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NWRF 33-0667-125

PHOTOGRAPHS FROM METEOROLOGICAL SATELLITES

(A COLLECTION OF THE PICTURE OF THE MONTH SERIES FROM *MONTHLY WEATHER REVIEW*, JANUARY 1963 TO MAY 1967).

NAVY WEATHER RESEARCH FACILITY
BUILDING R-[illegible] NAVAL AIR STATION
NORFOLK, VIRGINIA 23511

JUNE 1967

FOREWORD

In January 1963, *Monthly Weather Review* initiated a "Picture of the Month Series" for the purpose of disseminating particularly noteworthy meteorological satellite photographs. Prepared by the National Environmental Satellite Center, these photographs were until August 1966 concerned primarily with interesting and sometimes unexplained earth and cloud features. Since September 1966, this series has emphasized applications of satellite pictures in weather analysis and forecasting.

Inasmuch as *Monthly Weather Review* is not readily available to operating Naval Weather Service units, material contained in the 50 Picture of the Month articles from the beginning of this series to the most recent issue received (May 1967) has been assembled under one cover. To enhance the value of the compilation, the individual articles have been rearranged from their original chronological order into several groups of related photographs. In a few instances, due to the nonavailability to this activity of a photograph as large as that originally used, the satellite pictures appearing in this collection are smaller in size than those of *Monthly Weather Review*. It is not believed that any significant detail has thereby been lost.

This publication was compiled by Mr. René V. Cormier of this activity under NWRF Task 33, "Meteorological Satellite Analysis Techniques."

Reviewed and approved on 30 June 1967.

W. L. SOMERVELL, JR.
Captain, U. S. Navy
Officer in Charge
Navy Weather Research Facility

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(Note: *Monthly Weather Review* was published as a single combined issue for October-December 1963, hence there was only one Picture of the Month for that period. The October 1966 issue of *Monthly Weather Review* did not contain a Picture of the Month.)

1. Introduction to Picture of the Month Series
(January 1963)

Meteorological satellites are currently transmitting pictures of the earth's cloud distributions at a rate in excess of 500 pictures per day. Since the inception of the TIROS program, up to the present time, over 145,000 pictures have been received. It is difficult to overestimate the value of these pictures not only for operational forecasting and tracking of severe tropical storms, but also for meteorological research, for, after all, the cloud distributions are a direct effect of certain physical processes which were going on in the atmosphere.

Tantalizing questions are presented to the meteorologist working with TIROS photographs. almost every time he looks at a new set of pictures. Yet, until now, only limited use has been made of this wealth of information. Scientists in the Meteorological Satellite Laboratory of our Center have used about 700 pictures in research notes and articles. Other studies have made at least a partial use of the satellite pictures, but this does not begin to exhaust the research possibilities.

For a long time to come, satellite cloud pictures will furnish the only means of covering on a global scale the patterns of weather. Therefore, any effort which can be expended to learn how to interpret these cloud pictures in terms of more conventional meteorological parameters will be of great use in the operational application of these pictures, which is the primary function of our Center.

We are taking many different avenues to acquaint meteorologists as well as scientists in other fields with the great potential of satellite pictures. One of the methods commences here with the first of a series of "Picture of the Month" to be published in the *Monthly Weather Review*. This series will represent particularly puzzling phenomena which have defied any simple interpretation. Also in this series will be published pictures of unusual quality suggesting a potential for other applications, such as geography, oceanography, etc. Together with the picture we will present an informative legend giving as much documentation as possible, such as synoptic background, and, where possible, interpretation. We welcome inquiries from all interested scientists, particularly in universities, who would like to work on the interpretation of such pictures.

S. Fred Singer
Director
National Weather Satellite Center

2. VORTICES

PICTURE OF THE MONTH

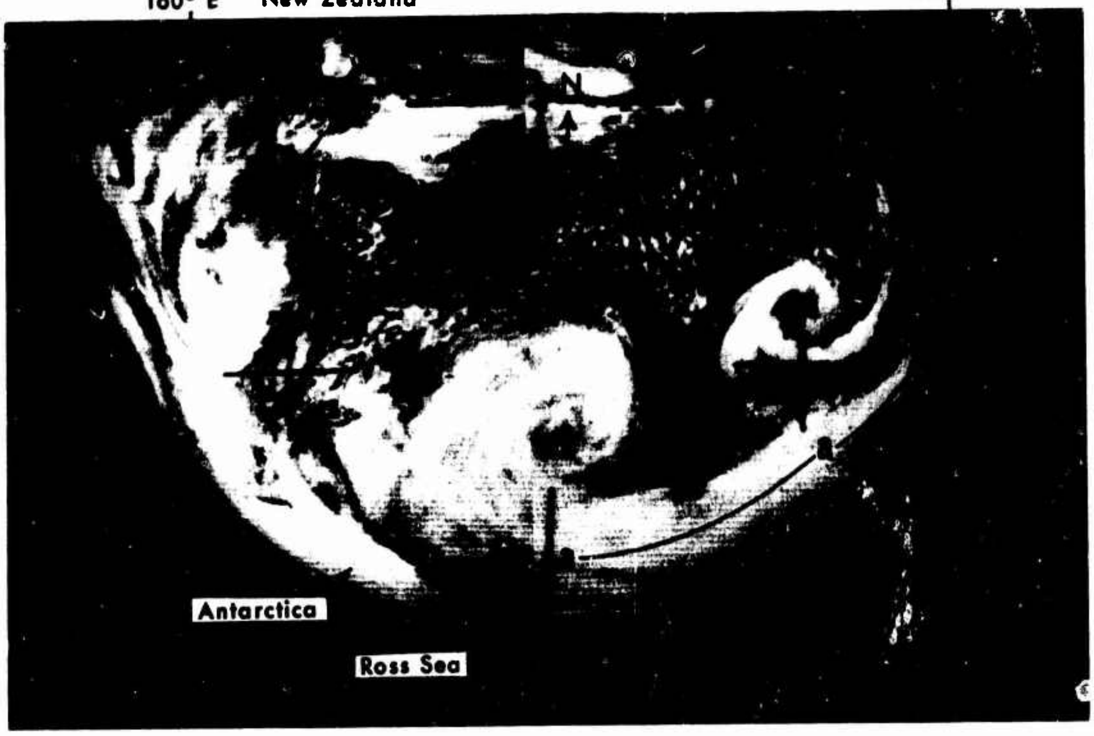
(July 1963)

This TIROS V photograph (pass 542 541, frame 12) was taken over the far southern Indian Ocean on July 27, 1962, at approximately 0720 GMT, and was received at Wallops Station via tape mode. North is roughly toward the top of the picture.

The two apparent vortices are only about 450 miles apart, an unusually short distance for synoptic-scale features. The one on the left is centered approximately at 55° S., 103° E., and the one on the right near 54° S., 115° E. Zone time at the 105th meridian would be about 2:20 p.m., but at these far southern latitudes in July the sun is near the northwestern horizon at this hour. Twilight is invading the southeastern (lower right) portion of the picture. The alternate light and dark bands across the bottom are due to electronic interference and represent no real feature.

PICTURE OF THE MONTH

(January 1966)



TIROS IX, pass 203/202, Cameras 1 and 2, 0207 GMT, February 8, 1965.

Two distinct and clearly-defined centers of cyclonic vorticity are contained within this TIROS IX double photograph, taken over the far Southern Pacific Ocean. The major center is located near 58° S., 172° [illegible]; the secondary center is near 50° S., 156° W. The outline of South Island, New Zealand, has been added at upper left.

It is believed that the primary cloud vortex corresponds to a large, deeply occluded cyclone whose frontal system, as indicated by the major cloud band (a–a–a), has advanced very far to the east of the low center. The secondary disturbance is within the cold air to the rear of the major frontal band, and it represents an unusually well-defined vorticity center although possibly not a closed cyclonic circulation. The slight northwestward bulge of the cloud band in the area just beneath the fiducial cross-mark may have been induced by the approaching vorticity maximum. Overall, the entire cyclonic system seems somewhat "inverted," with convective clouds marking the presence of unstable cool air equatorward of both disturbance centers.

Detailed conventional data to corroborate all of the foregoing are not available. However, copies of the 0000 GMT and 1200 GMT surface and upper-air analyses for February 8 from the International Antarctic Analysis Center, Melbourne, Australia, do indicate, on the basis of peripheral data, a large area of low pressure centered near 58° S., 170° W.

PICTURE OF THE MONTH
(August 1963)

Many TIROS pictures have revealed the spiral cloud arrays associated with cyclonic vortices. This particular example, more outstanding than most, is a TIROS VI photograph taken over the North Atlantic Ocean southeast of Nova Scotia on May 29, 1963, at 1005 GMT, and received at Wallops Island, Va., on Pass 3692/3691. The camera was looking toward the northwest (top of picture).

At the time of this photograph, the synoptic analyses showed the cyclone to be well occluded, but of only moderate intensity, and filling slightly. It was partially cut-off, with the 500-mb. Low (43°N., 59°W.) slightly northwest of the surface Low (41°N., 57°W.). The cloud pattern shown here is unusually well-defined, but its major features seem to be typical of many cyclones. In this instance the large spiral cloud band agrees quite closely with the surface position of the occlusion and cold front. However, the apparent center of the cloud vortex coincides more nearly with the position of the 500-mb. Low than with the position of the surface Low.

PICTURE OF THE MONTH

(November 1965)

TIROS IX, Pass 1257/1256, Camera 2, frame 11, 0851 GMT, May 6, 1965

This tightly-wound cloud spiral—much more compact in the central area than is usually observed—was photographed over Russia on May 6, 1965. The center of the cloud vortex was near 56° N., 44° E., approximately 200 n. mi. east of Moscow. North is indicated by the arrow.

In addition to the unusual compactness, such a clearly-defined cloud vortex is rarely seen over land; convective and orographic influences generally tend to mask and disarrange the land-based cloud spirals. It is not surprising to discover that this cloud vortex occurred over relatively flat terrain and that it was associated with a nearly stationary, well-occluded, cold-core cyclone whose structure had changed little during the preceding 24 hr. At the time of the photograph the cyclone was of moderate intensity (998 mb.) and was nearly vertical—the surface Low, the 500-mb. Low, and the cloud vortex were all centered near 56° N., 44° E.

The solid cloud band spiraling into the vortex from near the eastern horizon corresponds to the occluded front. It consists mainly of middle and upper-level stratiform layers and is 100–150 mi. in width. Mixed convective and layer-type clouds at low and middle levels occupy the central area of the cyclone, with most surface stations in that area reporting light precipitation at 0600 GMT. The existence of high clouds near the vortex center was not determined because of the presence of lower overcast.

The other major cloud band, near and roughly parallel to the bottom of the picture, does not correspond to any well-defined feature on the surface or 500-mb. charts. The band may be associated with a jet stream, but the necessary upper-level data to verify this conjecture are not immediately available.

The small, irregular whitish patches northwest of the vortex are lakes whose surfaces are partially ice-covered.

PICTURE OF THE MONTH
(February 1964)

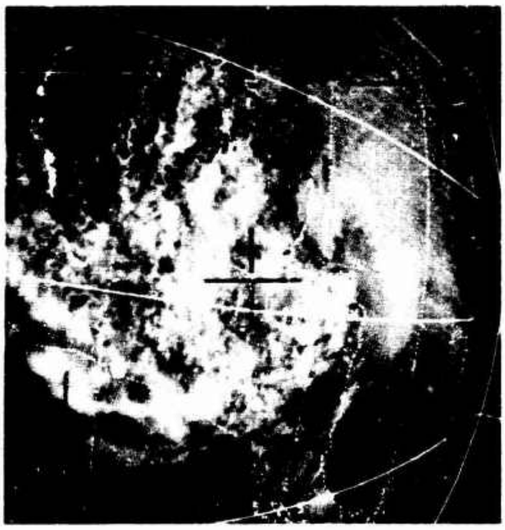
This TIROS VII photograph of the Caspian Sea area (pass 2278 2276, frame 27) was taken on November 20, 1963, at 0924 GMT and was received at Pt. Mugu, California, via tape mode. North is roughly toward the top of the picture.

The apparent small vortex or cyclonic swirl of cloud is centered over the middle of the Caspian Sea itself. Its existence is not obvious from the conventional surface data. The surface synoptic analysis for 1200 GMT shows the general area was under a weak ridge of high pressure, but with the remnants of a trailing cold front extending over the Caspian Sea from the northeast. The cloud spiral could have been associated with the trailing cold front, but it might also have been mechanically induced by flow across the mountains to the west, or thermally induced by surface heating from the relatively warm sea.

The snow-covered Caucasus Mountains can be seen extending west-northwest from near the center-cross fiducial mark.

PICTURE OF THE MONTH

(August 1966)



(a) ESSA-1, Pass 1743, Camera 1, Frame 7, June 4, 1966, 1943 GMT.

(b) ESSA-1, Pass 1757, composite of three photos, June 5, 1966, approximately 1908 GMT.

(c) ESSA-1, Pass 1[illegible], Camera 1, Frame 6, June 7, 1966, 1938 GMT.

(d) Nimbus II, Pass 338, APT, June 9, 1966, 1641 GMT.

The photos of hurricane Alma, the unusually early tropical cyclone of the 1966 Atlantic season, give the most complete satellite coverage yet obtained of the life history of an individual tropical storm. (a) and (b), taken on June 4 and 5, show the large cloudy area having a crude spiral configuration associated with the developing depression in the northwestern Caribbean Sea. Highest surface winds at the time of (b) were approximately 30 kt.

(c) shows the developed hurricane moving slowly northward toward western Cuba. Two days later (d) the storm center was nearing the Florida Panhandle, with a large shield of spiral bands extending to the Carolinas and far out over the Atlantic. The coastlines of southern Florida, Yucatan, and western Louisiana are visible.

Of interest in (d) is the unusually reflective water (see arrow) adjacent to the west coast of southern Florida. It is not known whether this was caused by foaming surf in the shallow waters, or whether it represents light colored sediment or other material stirred up by the passage of the storm.

PICTURE OF THE MONTH
(December 1966)

EDWARD W. FERGUSON

National Environmental Satellite Center,
Environmental Science Services Administration, Washington, D.C.

Some of the heaviest precipitation in the southwestern United States occurs when a tropical storm is located off the west cosat of Mexico and a southwesterly upper-level flow prevails over the region. At the time of the satellite picture shown in figure 1 hurricane Helga (A) was centered at about 20° N., 116° W., and 500-mb. heights were rising in western Mexico. The development of this High caused an increase in southwesterly flow over northwestern Mexico and southern Arizona (fig. 3). The resulting advection of moisture from hurricane Helga is evidenced in the satellite picture by the mass of convective clouds north of 30° N. at 110° W. These clouds are due primarily to orographic effects along the mountains in northern Mexico and southeastern Arizona.

Showers and thunderstorms were occurring over parts of Arizona at 1500 GMT (fig. 2). As hurricane Helga moved northward and the high pressure center continued to build over Mexico, the amount of cloudiness and the intensity of the precipitation increased. The Phoenix River District reported local amounts of 2 to 5 in. of rain during the 24-hr. period subsequent to the time of figure 1. It is significant that the heaviest rain occurred when hurricane Helga was some 500 mi. off the coast of Mexico; by the time the storm had moved to central Baja California, the heaviest precipitation had ended over the southwestern United States.

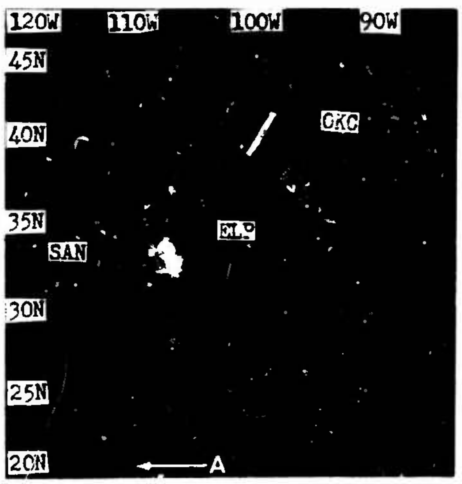


FIGURE 1.—ESSA 2 APT photograph, 1540 GMT September 12, 1966. SAN = San Diego, ELP = El Paso, OKC = Kansas City.

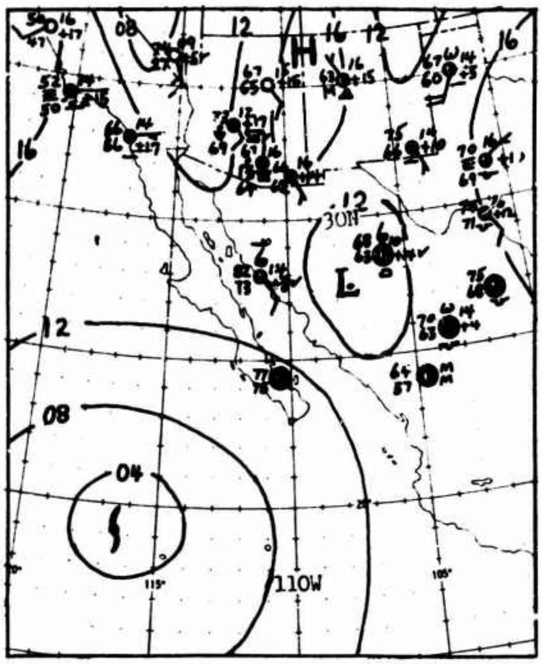


FIGURE 2.—Surface analysis, 1500 GMT September 12, 1966.

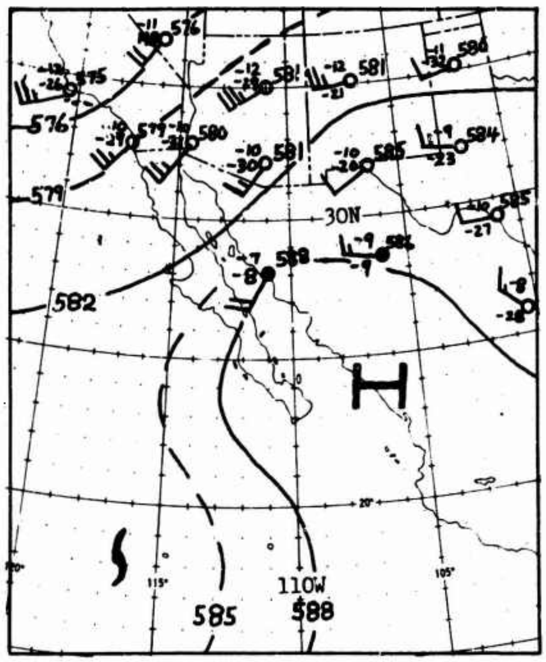


FIGURE 3.—500-mb. analysis, 1200 GMT September 12, 1966.

PICTURE OF THE MONTH
(January 1967)

E. W. FERGUSON AND F. C. OPATKA

National Environmental Satellite Center,
Environmental Science Services Administration, Washington, D.C.

A cold polar outbreak on November 2, 1966 brought record-breaking low temperatures and snowfall to many parts of the central and southeastern United States. The surface map for 1800 GMT (fig. 1), shows a surface Low in eastern Kentucky and snow falling as far south as Montgomery, Ala.

Figure 2 shows the cloud pattern associated with this system. The broad multilayered cloud band between points A and B is the cold front; the narrow cloud bands around C are in the cold air west of the front. Clouds associated with the early snowfall extend in a broad

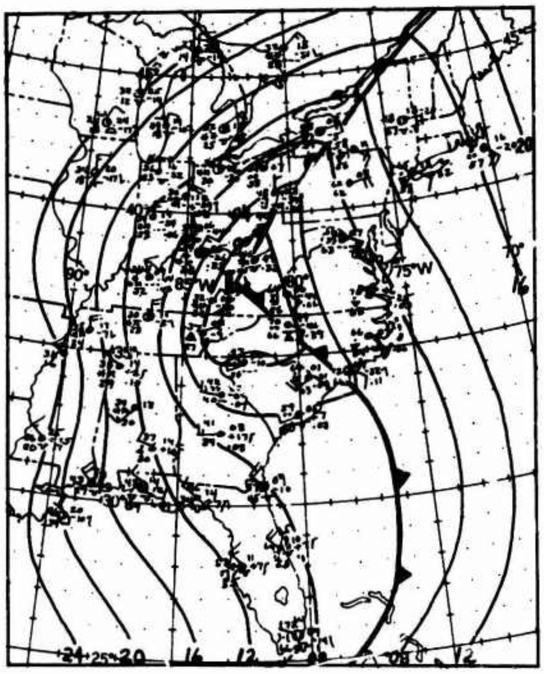


FIGURE 1.—Surface chart 1800 GMT, November 2, 1966.

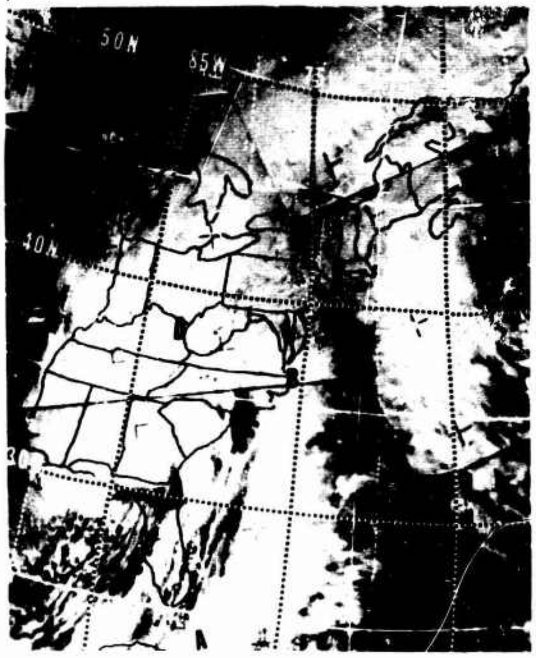


FIGURE 2.—ESSA 3 photomosaic. Passes 392–393, 1632–1832 GMT, November 2, 1966.

FIGURE 3.—ESSA 3 photomosaic. Passes 405 406, 1721–1916 GMT, November 3, 1966. The narrow dashed lines near the center of the picture are snow depth contours for 1200 GMT, November 3, 1966. The closed contour in central Kentucky indicates a 15-in. snow accumulation.

semicircle to the northwest and southwest of the low center near point D.

Figure 3 shows this area 24 hours later. The storm center (D) has moved into southwestern Quebec and the cold frontal band is located off the east coast of the United States. To the rear of the front, the cloud bands at E are the result of cold air advection over the relatively warm waters of the Gulf of Mexico and the western Atlantic. The new snowfall left in the wake of the storm is visible from northern Alabama to the Great Lakes. The 1-in. and 6-in. snow depth contours in this figure outline the areas of new snow. The closed contour over central Kentucky shows the area of 15-in. snow accumulation.

This snowfall was 4 to 6 weeks earlier than the average date of occurrence of 1 in. or more in lower Michigan, eastern Indiana, and western Ohio. Nashville, Tenn. recorded 5 in. of snow, while some areas of central Kentucky received a foot or more. This was the earliest snow on record in Meridian, Miss. and Montgomery, Ala.

New records for the lowest temperature this early in the season were reported in the eastern Plains and Mississippi Valley. A reading of 10° F. at Topeka, Kans. established a new low for this early in the season and the 28° reported at New Orleans is the lowest on record there for the month of November.

PICTURE OF THE MONTH
(April 1967)

EDWARD W. FERGUSON AND FRANCES PARMENTER
National Environmental Satellite Center, ESSA, Washington, D.C.

At 0000 GMT February 8, 1967, a 500-mb. trough with a closed center of positive vorticity lay over the Texas-New Mexico border (fig. 1). The surface analysis (fig. 2) shows a cold front in the inverted trough over western Texas.

The accompanying ESSA 3 photomosaic (fig. 3) shows the cloud pattern (outlined in white) associated with the surface and 500-mb. systems. Of interest is the cloud band, extending from the Texas-New Mexico border at 105°W., northeastward to 36°N., which bends cyclonically into a center in central New Mexico. This comma-shaped configuration is typical of the shape of cloud pattern produced in a region of positive vorticity. (It is unusual to observe this feature over land although it is common over oceanic areas where the effects of friction are less and moisture is more plentiful.) The striations in the cirroform cloud shield which emanate from a point west of P and extend northeast to Q, suggest sharp anticyclonic flow in the upper levels.

Much of the bright area near R and northward is snow on the Rocky Mountains.

The cloud band in the lower right corner of the mosaic is associated with a cold front extending across the Gulf of Mexico.

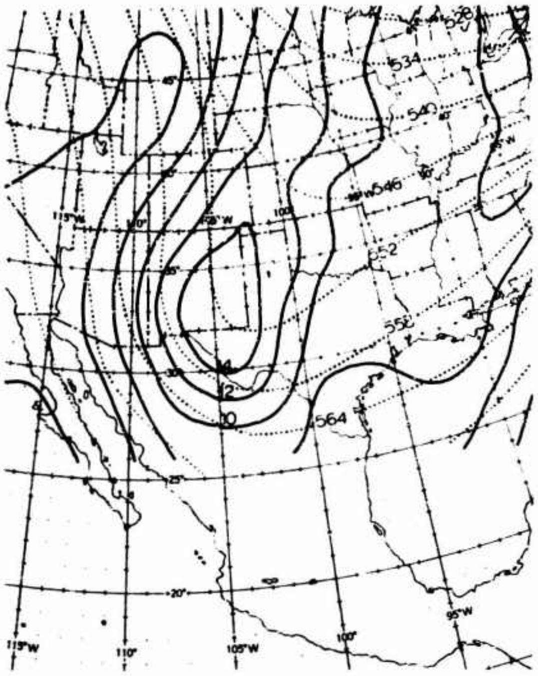


FIGURE 1.—500-mb. analysis, 0000 GMT, February 8, 1967. Solid lines represent vorticity contours and dotted lines 500-mb. height contours.

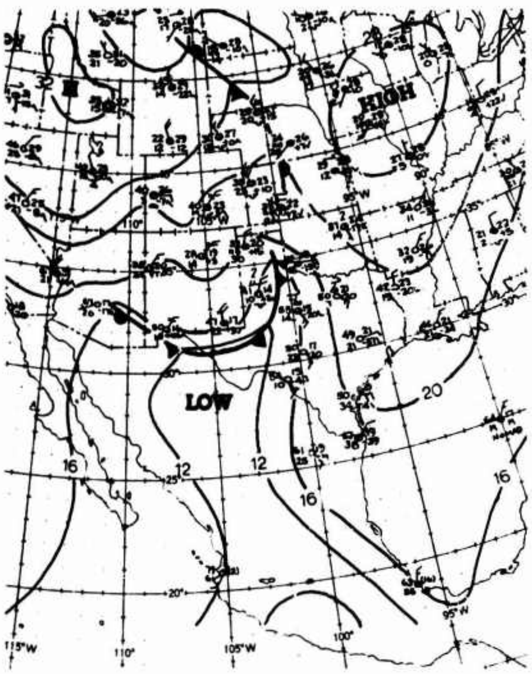


FIGURE 2.—Surface map, 2100 GMT, February 7, 1967.

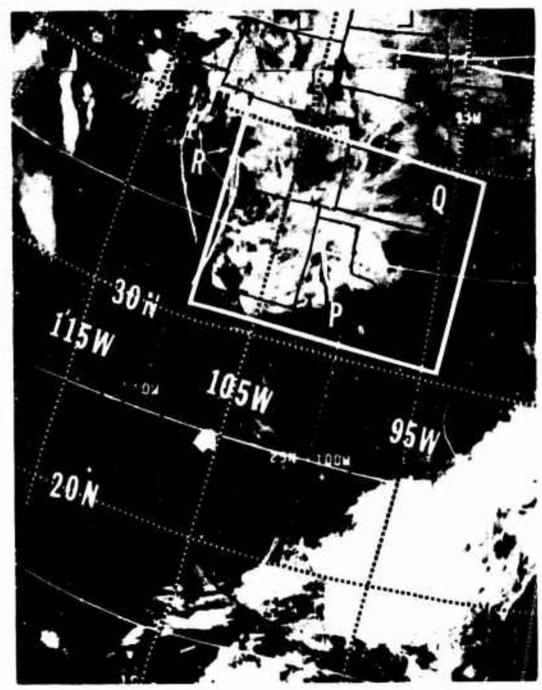


FIGURE 3.—ESSA 3 photomosaic. Pass 1612, 2006 GMT, February 7, 1967.

3. BANDS AND/OR LINES

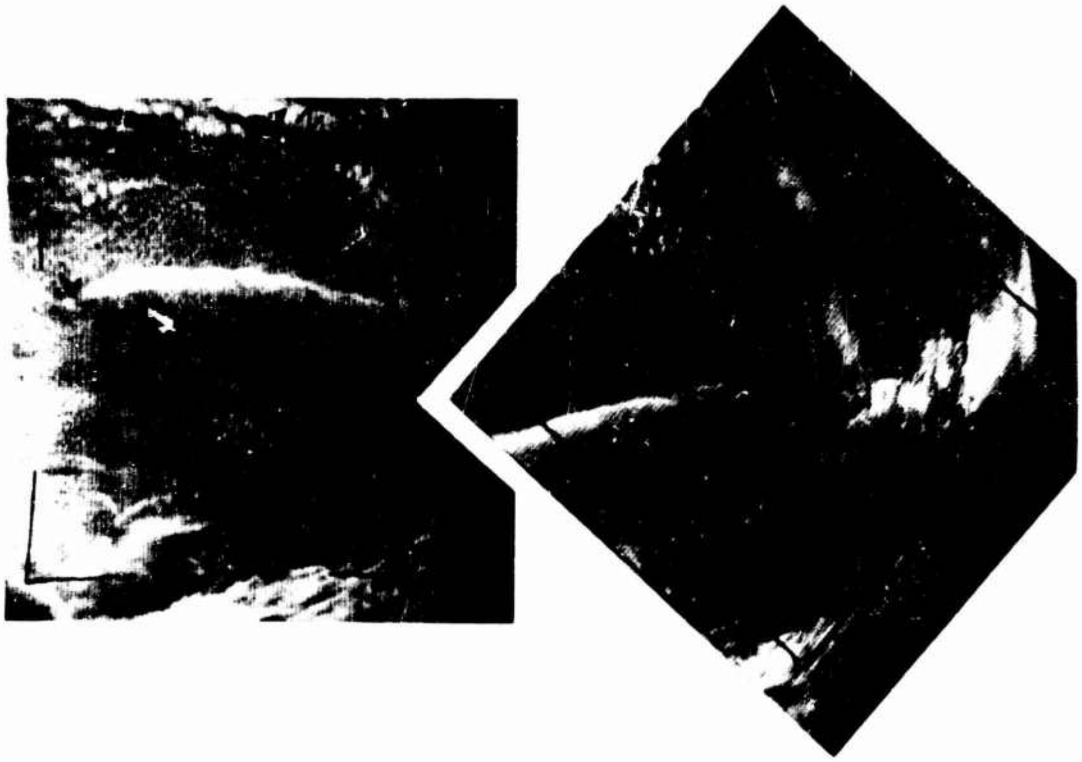
PICTURE OF THE MONTH
(April 1963)

This TIROS V photograph was taken on December 14, 1962, at 1036 a.m. PST on pass 2555 and was received at Pt. Mugu, Calif., via direct readout.

The well-defined streak of cloud, oriented nearly west-east across Baja California is an unexplained feature. It might be an aircraft condensation trail, but it is far south of most air routes, and the width of the streak in its western portion seems to preclude this explanation.

Some idea of the width of the cloud streak may be obtained by comparing it with other objects The 2-to-3-mile-wide channel between the Mexican Coast and Tiburon Island is not discernible in this picture, whereas the 7-to-10-mile-wide channel between the island to the northwest and Baja California shows up clearly. Therefore, the cloud line must be at least 3 miles wide over most of its length and is 10 to 15 miles wide in its western portion.

PICTURE OF THE MONTH
(September 1964)



These two TIROS V photographs (pass 4363/4362, camera 1, frames 28 and 26) were taken on April 19, 1963, at approximately 1917 GMT and were received at Point Mugu, Calif., via tape mode. Baja California is clearly visible in the photograph at right, and it also appears in the upper right corner of the picture at left. North is indicated by the arrows.

A striking and unexplained feature is the long streak of cloud oriented approximately WSW–ENE across the middle of both pictures. The western end of the cloud streak is located near a small bright cloud which is about 500 mi. southwest of Baja California, and the streak itself extends in an unbroken line nearly to the southern end of that peninsula. Broken and less well defined filaments continue across the peninsula and well into the mainland of Mexico. A somewhat similar cloud feature, occurring in the same general area, appeared as the April 1963 "Picture of the Month."

The cloud streak and the associated filaments almost certainly are composed of cirrus or cirriform clouds at a much higher elevation than the low-level stratocumulus present beneath the streak and to the north of it. At least three possible explanations may be offered, none of which seems entirely satisfactory:

(1) The cirrus streak was produced by upward motion in the high troposphere associated with a nearby jet stream;

(2) The small bright cloud near the western end of the streak is a cumulonimbus cloud that produced the long plume of cirrus;

(3) The cirrus plume is the outgrowth of an aircraft condensation trail.

PICTURE OF THE MONTH
(August 1965)

(a) TIROS VII, Pass 997/997, Camera 2, frame 23, August 25, 1963, 2037 GMT

(b) TIROS VII, Pass 5782/5773, Camera 1, frame 29, July 13, 1964, 2226 GMT

These TIROS VII photographs each contain features in the cellular cloud pattern that are not only unusual but also difficult to explain. The unusual features common to both are the narrow curved bands of clouds that appear to be embedded in the areas of cellular structure. Both pictures were taken over the western North Pacific Ocean during the summer; photograph (a) is centered near 38° N., 167° E., photograph (b) near 49° N., 155° E. North is indicated by the thin arrows.

The clouds in photograph (a) were associated with a deepening extratropical cyclone of moderate intensity (994 mb.). The somewhat irregular cloud band near and roughly parallel to the bottom of the picture is believed to coincide with the surface position of the cold front, and the cumuliform cloudiness visible to the north is within the cooler air to the rear of the front. The narrow, smoothly curved cloud lines apparently represent enhanced convection that is contained within the layer of low-level cumuliform cloudiness. While these narrow lines appear to be associated with the circulation about the cyclone, two of them are observed to intersect (heavy arrow)! Therefore, the lines cannot represent only a simple, cyclonically spiraling streamline pattern.

The cloud lines in photograph (b) are less smoothly curved, suggesting aircraft condensation trails. However, the fine structure of these lines appears almost identical with that of the lines in picture (a), and the lines seem to be at the same altitude as the adjacent low-level strato-cumulus masses. The synoptic analyses suggest nothing unusual. The surface map shows the area was in a weak easterly-to-southeasterly flow; the 500-mb. chart indicates a nearby col with generally light winds.

Photograph (b) was suggested for use by C. J. Bowley of ARACON Geophysics Company, Concord, Mass.

PICTURE OF THE MONTH
(May 1963)

These two TIROS III photographs, both received via tape mode at Wallops Station, Va., were taken about 2 months and 5,000 miles apart. Each shows strikingly large parallel bands over low-latitude, Southern Hemisphere ocean areas; and in both cases the bands are oriented very nearly east-west, with the width of each band of the order of 150 miles.

The picture on the left (pass 199/198, frame 7, 0620 GMT, July 26, 1961) was taken over the southern Indian Ocean northeast of Madagascar which is somewhere near the horizon to the left. The bands lie in the general area bounded by 50° and 70° E. and by 8° and 20° S.

In the picture on the right (pass 1121/1120, frame 3, 1203 GMT, Sept. 28, 1961) the bands are in the area between 5° and 15° S. and between 5° and 30° W. almost midway between Africa and South America. The Brazilian coast lies beyond the horizon to the left of this picture. Although the later TIROS III pictures, such as this one, suffered considerable image degradation, it still is possible to see that the bands are composed of numerous smaller cumuliform aggregates.

According to climatological averages, the Intertropical Convergence Zone should be north of the equator in July and September, and it is probable that these bands south of the equator and at low latitudes are in easterly or southeasterly winds about the periphery of an anticyclone—clearly not any familiar synoptic model.

What is the nature of this remarkable tropical convergence?

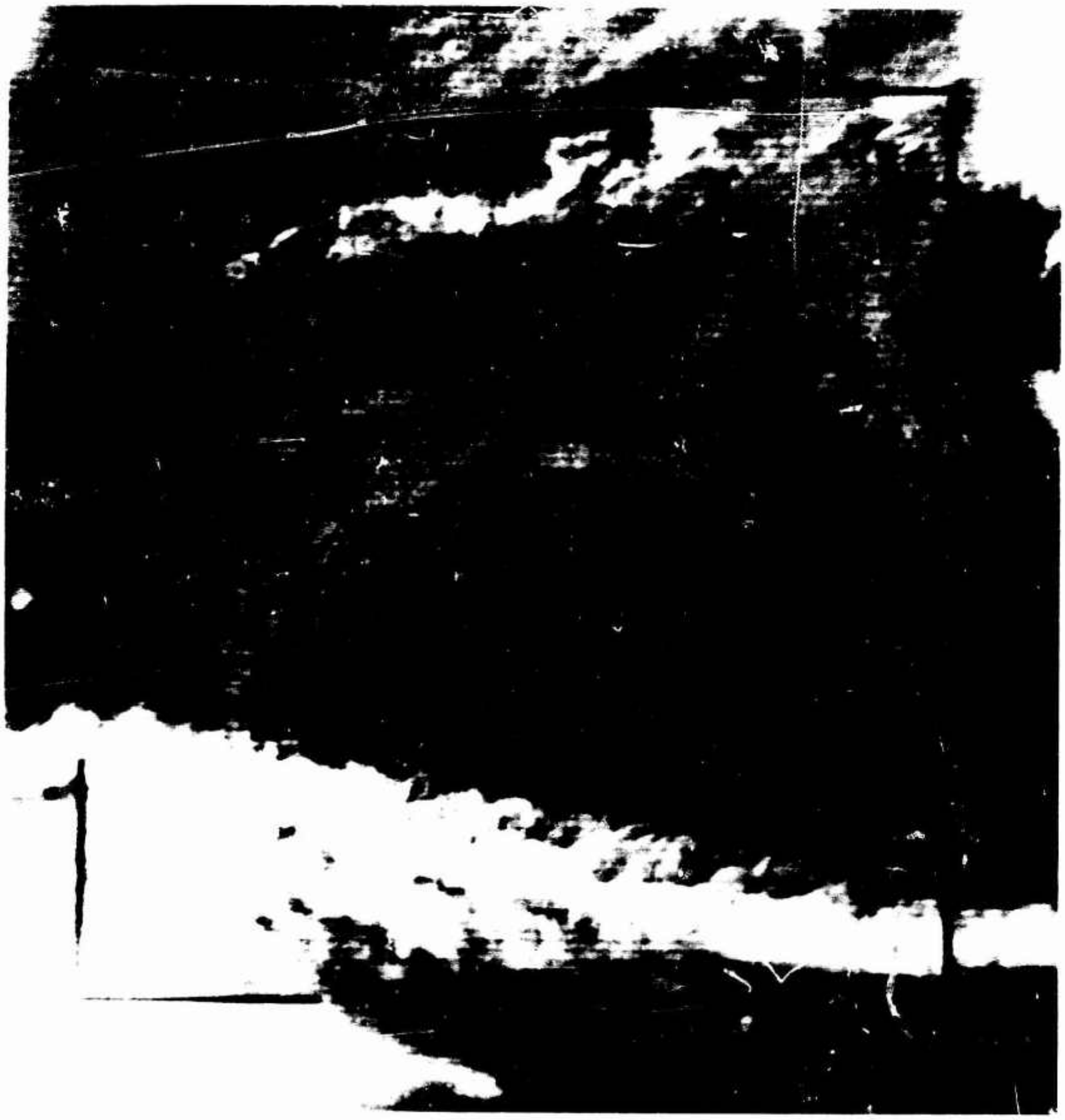
PICTURE OF THE MONTH
(June 1964)

Since the launching of TIROS I, occasional satellite pictures have revealed the existence of wave clouds, associated with the air flow across mountain ranges. This particular example is a TIROS VII photograph (pass 4363, camera 1, frame 10) showing such clouds over and to the east of the Appalachians. The photograph was taken on April 9, 1964, at 1309 GMT (0809 EST) and was received at Wallops Island, Va., via direct readout. North is roughly toward the top of the picture, with portions of the Great Lakes appearing in the upper left. The intersection point of the center-cross fiducial mark lies slightly to the east of Columbus, Ohio.

At the time of this photograph, a recent surge of cold air had invaded the eastern United States. The surface map for 1200 GMT, April 9, showed a high pressure center (1030 mb.) located over Arkansas, with west-to-northwest winds, near freezing temperatures, and scattered snow flurries over the Appalachian region. Strong westerly winds existed aloft.

The spacing of the individual cloud bands in the picture is approximately 10 statute miles. Surface stations in the area were reporting stratocumulus and altocumulus type clouds, and many aircraft reports of moderate to severe turbulence were received from in-cloud and below-cloud levels during the day.

PICTURE OF THE MONTH
(January 1964)



This unusually clear TIROS VII photograph of the northeastern United States (pass 063, frame 3) was taken on June 23, 1963, at 1634 GMT and was received at Wallops Station via direct readout. Long Island lies just above and to the right of the center-cross fiducial mark.

The large band of cloud across the lower part of the picture is oriented approximately ENE–WSW and is believed to have been associated with the jet stream. It consisted of cirrus and altocumulus type clouds. (Other pictures from this pass reveal that the band extended a considerable distance beyond the eastern border of the photograph shown here.) 300-mb. and 200-mb. charts for June 23, 1200 GMT show a Low centered over the Gulf of St. Lawrence, with strong westerly winds reported over middle Atlantic coastal stations from Nantucket to Norfolk.

At the surface, a mass of cool dry air covered the region, with high pressure (1030 mb.) centered over northern Ohio. The semi-stationary front marking the southern and eastern boundaries of this cool air extended from Georgia east-northeastward over the Atlantic, its surface position being approximately parallel to the lower border of this picture but slightly south of it and outside the picture area. Warm-frontal cloudiness over the eastern Carolinas is visible in the lower left corner.

PICTURE OF THE MONTH
(March 1964)

This striking cloud formation across the west coast of Mexico was photographed by TIROS VII (pass 2992/2991, frame 4) on January 7, 1964, at 1919 GMT. The picture was received at Wallops Island, Va., via tape mode. Portions of Baja California and the Gulf of California appear in the upper left.

The edge of the main cloud mass, oriented approximately northeast-southwest through the center-cross fiducial mark, is believed to be associated with the jet stream and to be roughly parallel to it and perhaps slightly south of the jet core. Detailed upper-wind information over this area is lacking, but farther north there was a deepening upper-air trough over the Rockies at this time, indicating the likely existence of strong southwest or west-southwest winds over the pictured area.

The clouds are believed to be mainly upper-level altocumulus and dense cirrus. Whatever their true nature, a remarkable structure of transverse bands is clearly apparent. In the region through the center-cross fiducial mark, individual bands are 10 to 20 mi. in width and are oriented nearly north-south. Toward the lower right corner, larger bands are seen curving out toward the southeast. Just above the center-cross fiducial mark and across its northern and western ends is an area of thinner cirrus which also shows a faint banded structure, here aligned north-northeast—south-southwest!

The small patch of clouds over Mexico, somewhat above and to the right of the center-cross mark, is believed to be lower-level cumulus clouds.

PICTURE OF THE MONTH
(May 1964)

This TIROS VIII photograph of a North Pacific cyclone (pass 764/762, camera 1, frame 13) was taken on February 12, 1964, at 0045 GMT and was received at Wallops Island, Va., via tape mode. North is roughly indicated by the arrow. The surface analysis for 0000 GMT, February 12, showed a deepening cyclone (990 mb.), beginning to occlude, centered near 40°N., 180°.

An overall general spiral pattern often is seen in TIROS pictures of cyclones, but the sharply defined cloud lines in this photograph are unusual. Three major cloud bands curve from the lower left to the picture right-center. The easternmost band suggests frontal clouds, and the center band, with many small transverse elements, is similar to a jet stream pattern. This interpretation appears to be inconsistent with surface data, however. The western thin curved band is not like anything usually seen in TIROS pictures.

The cumuliform cloudiness in the upper left quadrant undoubtedly represents low-level convection in the cold air to the rear of the cyclone.

PICTURE OF THE MONTH
(July 1965)

This broad frontal cloud band over the low latitudes of the Western North Pacific was photographed by TIROS IX (pass 627/624, camera 2, frame 15) on March 15, 1965, at 0105 GMT. The picture was received at Wallops Island, Va., via tape mode. A partial latitude-longitude grid is superimposed.

The striking feature is the well-defined, wavy rope-like appearance of the clouds along the southern boundary of the cloud band. It is believed that the surface position of the slowly-moving cold front is slightly north of the rope-like edge, but near the southern boundary of the band. The clouds are probably predominantly at low and middle levels, but some cirrus may also exist.

Similar rope-like cloud features associated with extensive cloud masses have been seen several times over subtropical ocean areas and are most often along the southern edge of a cold-frontal band as is the case here. No such feature has been observed at latitudes higher than 40° nor with fast-moving fronts.

The broad dark zone immediately south of the wavy edge is nearly cloudless and implies subsidence in the middle and low troposphere, while the bright wavy cloud line represents a very narrow line of upward motion. Clearly, the conventional frontal models cannot account for such a mesoscale pattern.

PICTURE OF THE MONTH
(February 1967)

Satellite photographs of oceanic areas at lower latitudes often reveal a bright, narrow, rope-like line preceding a cold front. Frequently this thin line is separated from the main frontal band at intervals by holes or zones of greatly reduced cloudiness. The TIROS IX photograph of February 25, 1965 (fig. 1) presents a fine example, showing the main frontal band (A) separated from the typical rope-like line (B) by holes such as at C. Although this phenomenon occurs mostly over data-sparse oceanic regions, a few cases are documented by radar observations. Results show the narrow lines to be convective clouds with tops ranging in general from 15,000 to 30,000 ft. "Unlike the squall lines of the Middle West the weather does not appear to be severe. Light showers and thunderstorms occur but nothing unusual has appeared." [1]

The radarscope pictures (fig. 2) show a narrow band oriented 038°–218° crossing Key West, Fla., shortly after 1000 GMT, February 25, 1965, moving from 310° at 22 kt. The Miami radar observations indicate passage at 1140 GMT of a line of showers and thundershowers 5 to 10 mi. wide and more than 300 mi. long, oriented 035°–215°, moving from 300° at about 20 kt. The orientation and movement of these lines are in excellent agreement with the position of the rope-like line in the satellite picture taken at 1753 GMT.

Both Miami and Key West observers reported rain showers and thundershowers, and cloud tops ranging from 18,000 to 30,000 ft. along the narrow line.

[1] L. F. Whitney, Unpublished Manuscript, December 31, 1965.

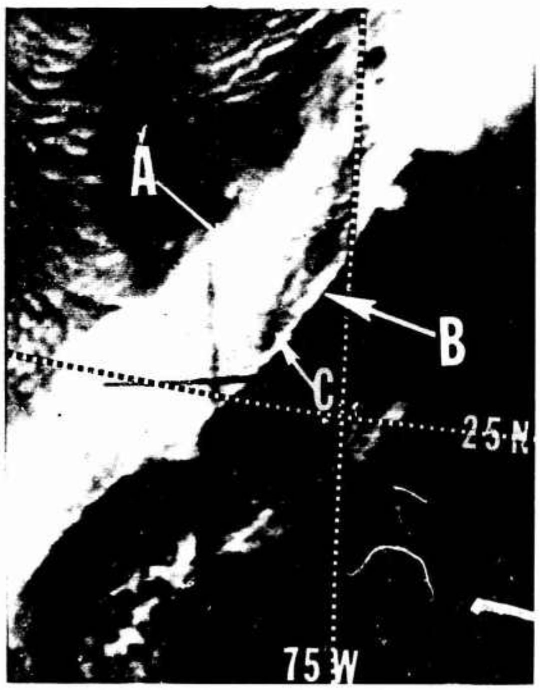


FIGURE 1.—TIROS IX photograph, 1753 GMT, February 25, 1965.

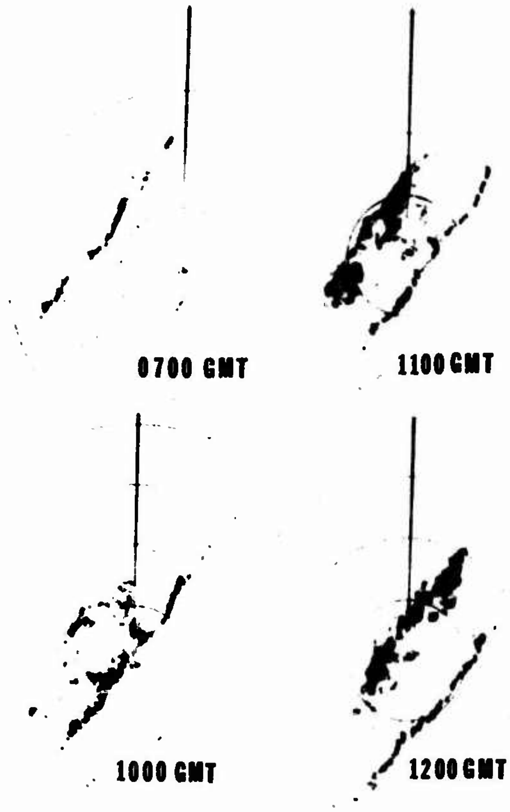


FIGURE 2.—Radarscope pictures taken at Key West, Fla., at 0700, 1000, 1100, and 1200 GMT, February 25, 1965.

PICTURE OF THE MONTH
(September 1966)

FIGURE 1.—An example of a prefrontal squall line. ESSA 1 photomosaic. Pass 1470, 1914 GMT, May 16, 1966.

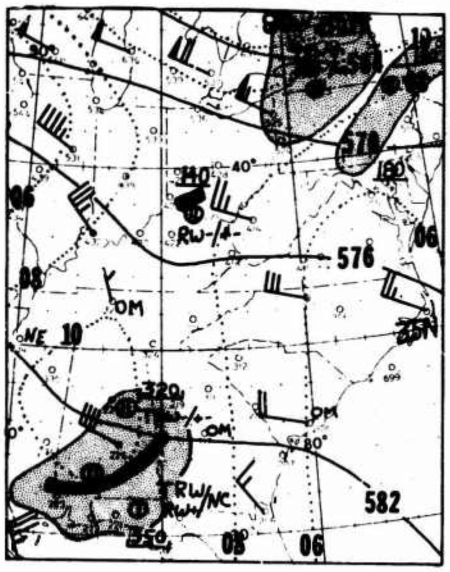


FIGURE 2.—500-mb. (solid lines) and vorticity (dotted lines) analyses. 1800 GMT, May 16, 1966. Prepared from 1800 GMT winds aloft data and interpolation between the 1200 GMT and 0000 GMT computer-analyzed height and vorticity fields. Radar reports are denoted by the shaded areas.

Commencing with this issue, the "Picture of the Month" will illustrate an operational application of the ESSA 1 television data or the Automatic Picture Transmission (APT) data from ESSA 2. Daily analysis of hundreds of satellite pictures at National Environmental Satellite Center has led to a large number of empirical picture interpretaton rules that have proven valuable for meteorological use. The widespread reception of APT from ESSA 2 provides the opportunity to present to a large audience the discussions that have formerly been available only to those at the analysis center and to expand the utility of these new data.

The ESSA 1 photomosaic (fig. 1) shows the cloud pattern associated with a squall line over southeastern United States. The analyses in figure 2 show that the squall line is located just in advance of a short-wave 500-mb. trough in the area of strongest positive vorticity advection. Radar reports near the time of the satellite pictures depict a solid line of echoes between points F and G (fig. 1). Small cloud lines tend to spiral toward a point and suggest a center of circulation at point A. This is in close agreement with the analyzed position of the surface Low over northern Alabama (fig. 3). The large shield of clouds east and northeast of the squall line is mostly cirrus that has sheared from the tops of the thunderstorms which developed in the area of maximum vertical motion. This cloud shield is being advected northeastward. However, it exhibits striations (B) that taper toward the southeast (points C) which indicate anticyclonic turning of the high-level winds. This anticyclonic turning causes the dissipation of the cirrus near the east coast (points C). The multilayered cloud band of the cold front lies between points D and E.

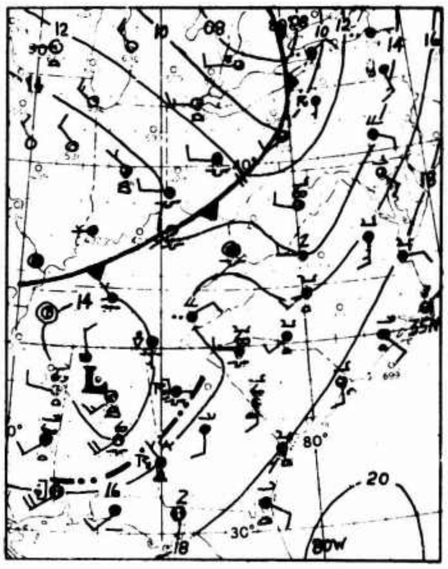


FIGURE 3.—Surface analysis 1800 GMT, May 16, 1966.

PICTURE OF THE MONTH
(November 1966)

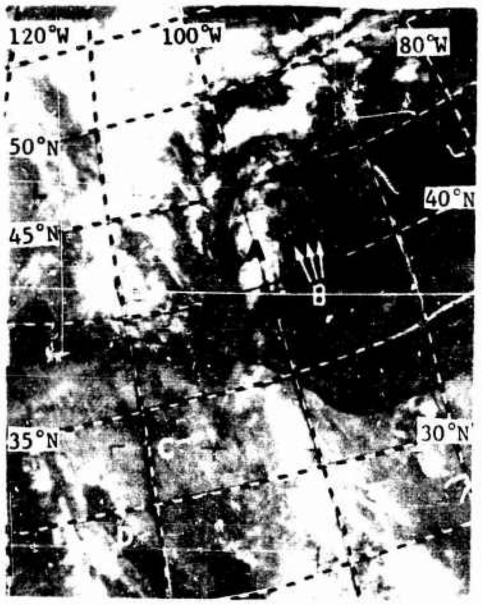


FIGURE 1.—ESSA 2 APT (Automatic Picture Transmission) photomosaic, 1553 GMT June 22, 1966.

The ESSA 2 APT photomosaic (fig.1) shows the cloud pattern (A) associated with a developing squall line in central Nebraska. The convective activity developed in a tongue of warm moist air which at 850 mb. (fig. 2) extended north-northeastward from New Mexico to the Dakotas. The squall-line cloudiness was just in advance of a short-wave 500-mb. trough (fig. 2).

Of particular interest are the small bands of cirriform clouds (B) which emanate from the north side of the cloud mass and turn sharply anticyclonically to extend east of the main cloud mass. This cloud pattern is typical of squall lines which form along narrow warm tongues. These bands of high-level clouds (B) are aligned parallel to the thermal wind, as shown in the 1000–500-mb. thickness analysis in figure 3, and are also parallel to higher-level isotherms. The squall line activity moved northeastward, intensified during the 6-hour period subsequent to the time of the APT photomosaic shown here, and then dissipated.

Other features of interest in figure 1 are White Sands, New Mexico, which appears as a small white dot at point C, and the Gulf of California which is visible at D.

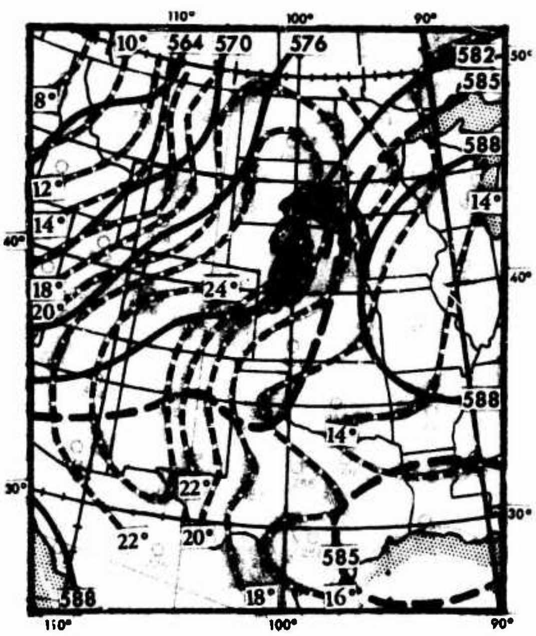


FIGURE 2.—500-mb. analysis (solid lines) and 850-mb. isotherms (dashed lines), 1200 GMT June 22, 1966. Stippled area denotes clouds associated with squall lines seen in figure 1.

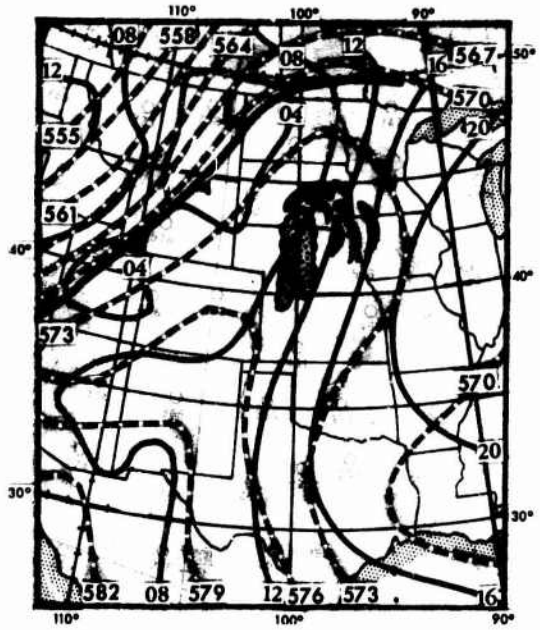
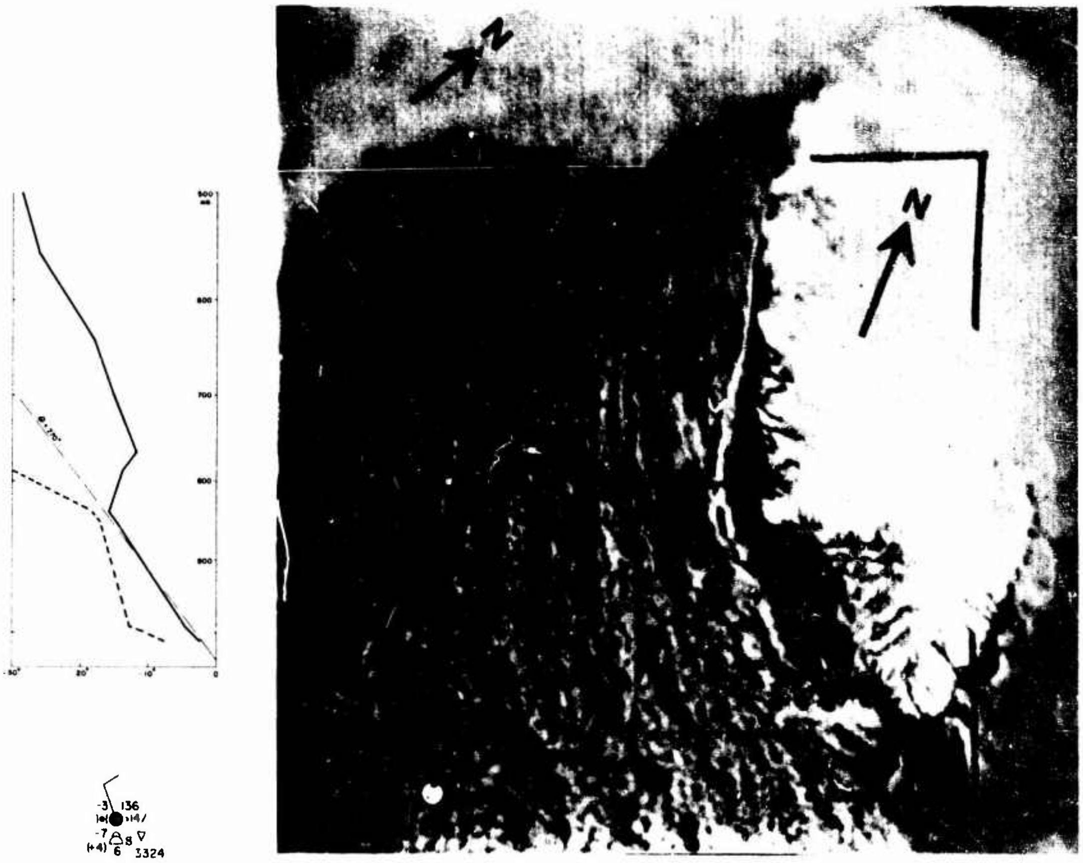


FIGURE 3.—Surface analysis (solid lines) and 1000–500-mb. thickness analysis (dashed lines), 1200 GMT June 22, 1966. Stippled area denotes squall-line cloudiness seen in figure 1 and solid shading represents radar echoes observed at 1445 GMT.

PICTURE OF THE MONTH
(April 1966)



TIROS VII, Pass 4365/4364, Camera 1, frame 13, 1456 GMT, April 9, 1964. Plotted data are for Ship "B" (56.5° N., 51° W.), 1200 GMT, April 9, 1964.

The Greenland Ice Cap and some remarkable low-level convective cloudiness are clearly visible in this photograph taken at 1456 GMT, April 9, 1964. Plotted at left are the 1200 GMT surface and radiosonde observations from weather ship "B", which was located within the photographed area near the lower left corner. North is indicated by the arrows.

The surface synoptic analysis for 1200 GMT, April 9, showed a weak ridge of high pressure extending from northern Greenland to the Labrador Coast, indicating that most of the area was under a moderate northerly or northwesterly flow of Arctic air. Temperatures at stations along the west coast of Greenland ranged from −28° C. at Thule in the far north (outside pictured area) to −5° C. at Prins Christians Sund near the southern tip. The region of Davis Strait, between Greenland and Baffin Island (upper center of photograph), was largely filled with sea ice; it is believed that air flowing southward from that region was initially some 15° to 20° C. colder than the underlying water. Numerous small parallel cloud lines appear over the open-water area south of Davis Strait. These are thought to represent an initially shallow but very unstable low-level convective layer characterized by strong heating from below. Farther south, at ship "B", a near-adiabatic lapse rate has been created up to 837 mb., topped by an inversion in the layer 837–765 mb. Narrow cloud lines are no longer in evidence; instead the appearance is one of a cellular cloud pattern with cells arranged in much larger, ill-defined coarse lines.

Similar patterns in less well-developed form are frequently seen. Preliminary studies indicate that all occur within a rapidly deepening layer of heated air.

A portion of the west coast of Greenland is bordered by clear air while a line of enhanced convection appears offshore. This line of enhanced convection probably represents the convergence of low-level drainage from the ice cap with the general southward and southeastward flow of air from Davis Strait.

4. CUMULUS PATTERNS

PICTURE OF THE MONTH
(January 1963)

TIROS V, 1500 GMT, October 7, 1962. Numbered cloud pattern is along 7° S between 87° and 97° W.

It is appropriate that this series begins with a type of cloud pattern discovered on TIROS pictures. The numbered arrows indicate a line of actinoform patterns presumably in various stages of development. Numbers 4 and 5 almost merge and 1 is poorly organized, but the typical pattern is easily seen in 2 and 3.

The first example of this was seen on August 16, 1962 when TIROS V revealed a single pattern such as this, centered about 100 miles south-southwest of Hawaii. The simultaneous surface observation at Hilo, Hawaii, reported "low cloud 8" made up of 2500 ◐, 5000⊕. Although Hilo was within 30 mi. of the edge of this pattern the clouds of interest lay 30 to 200 mi. cross-wind from the observation point and it is possible the observations are not entirely representative. Since then several other pictures of like patterns have been obtained, but none near surface observations.

The common features of these actinoform patterns are:

1. All have occurred in the Tropics or subtropics.
2. All have occurred where there was an observed inversion or the likelihood of one. The Hawaiian Island case showed a well-developed trade wind inversion somewhat below normal height. The location of the case pictured here suggests the probability of an even lower inversion.
3. The individual pattern near Hawaii was about 200 mi. in diameter. The ones pictured here are about 125 mi. in diameter.
4. The cloud field in the vicinity is the type already known to be associated with low-level inversions.
5. The radial arms have a weak tendency to curve in one sense. The case in the Northern Hemisphere curved clockwise outward, those in the Southern Hemisphere, counterclockwise outward.

PICTURE OF THE MONTH

(April 1965)

(a) TIROS V, Pass 838/837, Camera 1, frame 26, August 16, 1962, 2322 GMT

(b) TIROS VIII, Pass 3049/3048, Camera 1, frame 17, July 18, 1964, 1713 GMT

Radial or semi-radial cloud patterns over the tropical and subtropical oceans have been seen in numerous satellite photographs. Outstanding examples, such as those shown here, are rare; but similar patterns in less well-developed form are commonly observed. They are most frequently seen in the low latitudes of the Eastern Pacific.

Photograph (a) shows a single such pattern, approximately 200 miles in diameter, centered near 17.5° N., 155° W., about 100 mi. south-southeast of Hawaii. Photograph (b) reveals several somewhat smaller patches in the South Pacific Ocean west of Peru. The picture center is at approximately 15° S., 100° W., and individual patterns are roughly 100–150 mi. in diameter. A third outstanding example was presented as the very first "Picture of the Month" (*Monthly Weather Review*, January 1963, p. 2), and the reader is referred to the text accompanying that picture for additional information.

Because these patterns occur within sparse-data areas, few nearby conventional observations are available, and none from within the patterns themselves. Why should such strikingly different modes of convection exist side-by-side over a relatively uniform ocean surface?

(Note: Pictures reproduced above differ by one frame number from pictures appearing in the Monthly Weather Review. Accordingly, the locations specified in the text are somewhat in error.)

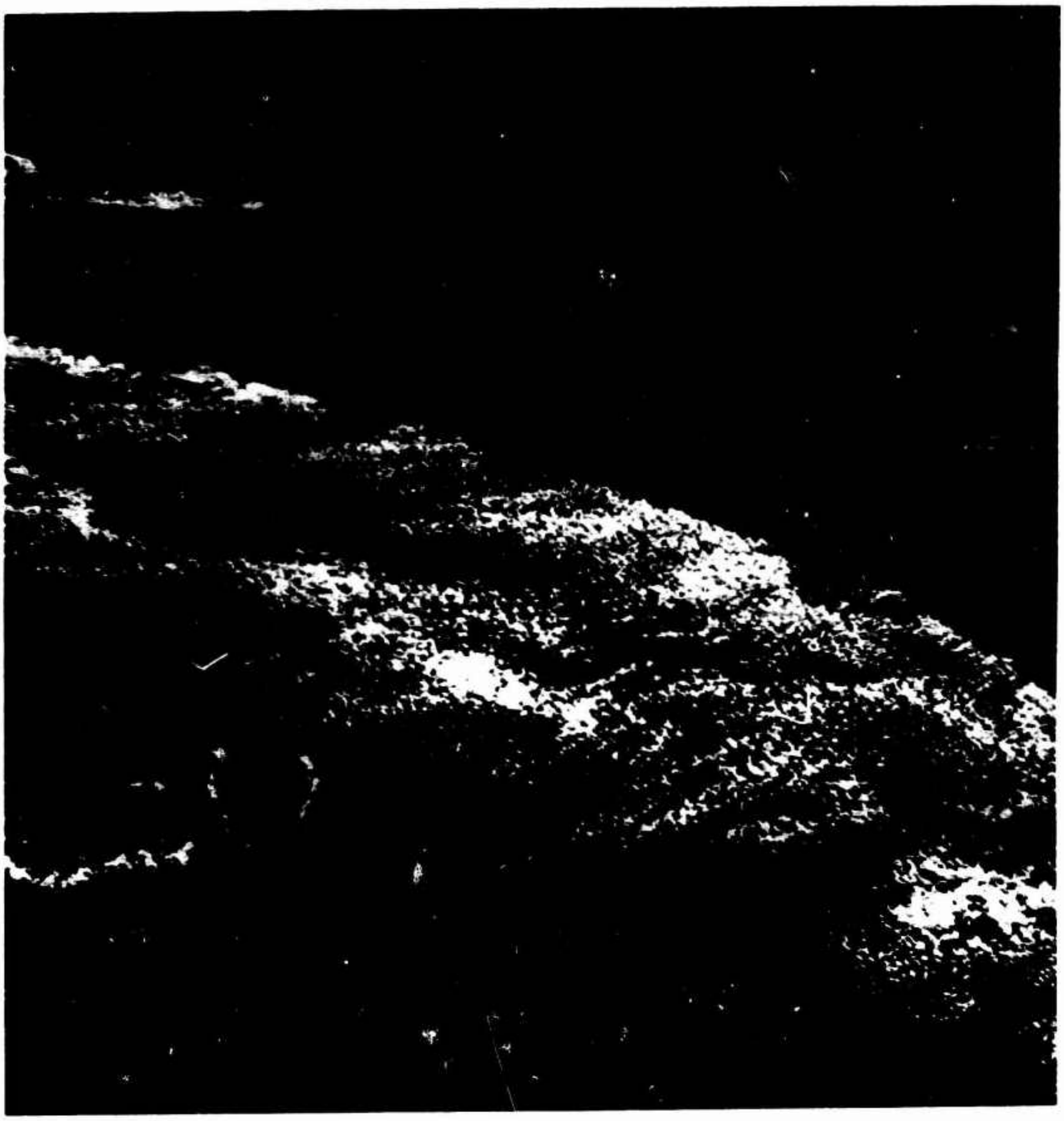
PICTURE OF THE MONTH

(March 1963)

This TIROS IV picture received at Wallops Island, Va., on April 14, 1962, Pass 920/919 shows England, Scotland, and Ireland, and a part of the French and Belgian coasts. Local London time was 1:20 p.m.

The curious and puzzling feature is that England and Scotland are sharply delineated by afternoon cumulus clouds, while Ireland is only dimly seen because the cloudiness is so poorly developed that it is lost in the gross resolution of TV scan lines. The sharp cloud discontinuities at the English coast indicate the cumuli were produced by the warm land but why is only England so favored?

PICTURE OF THE MONTH
(September 1965)

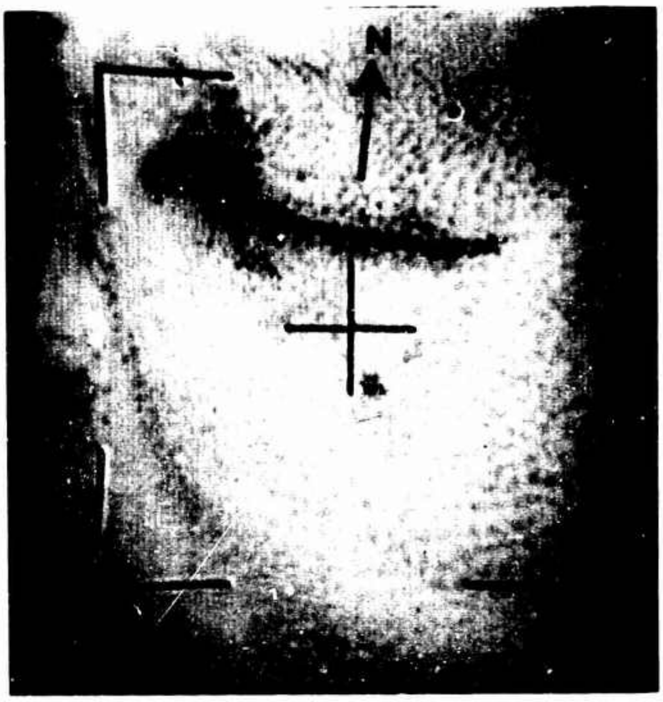


This photograph, looking southwestward across Cape Kennedy, central Florida, and the Gulf of Mexico, is one of many outstanding pictures taken by astronauts James McDivitt and Edward White during the Gemini-4 spaceflight. It is the first photograph to appear in the "Picture of the Month" series that is not a television photograph. The picture was initially recorded on 70-mm. color film; this black-and-white reproduction, although remarkably detailed, does not do justice to the original version.

The photograph was taken at 1250 EST, June 5, 1965. Daytime convective cloudiness is concentrated over the land area of central Florida, with the water areas of the Atlantic and Gulf relatively cloud-free. Over Florida a light easterly flow existed at all levels below 500 mb., and there is a slight tendency for the cumulus clouds to be aligned in east-west rows, roughly parallel to the flow. The large "hole" in the clouds at left center is in the vicinity of Lake Okeechobee; at right center the indentation along the Florida west coast is near Tampa Bay. Toward the upper left, lines of cumuli mark the Florida Keys and western Cuba. At the extreme upper left, near the horizon, is a cumulonimbus cloud with anvil top shearing off toward the southeast.

The altitude of the Gemini-4 spacecraft at picture time was approximately 180 km. Cape Kennedy, which appears in the foreground, is nearly 200 mi. distant from the camera. Lake Okeechobee and Tampa Bay are about 300 mi. distant.

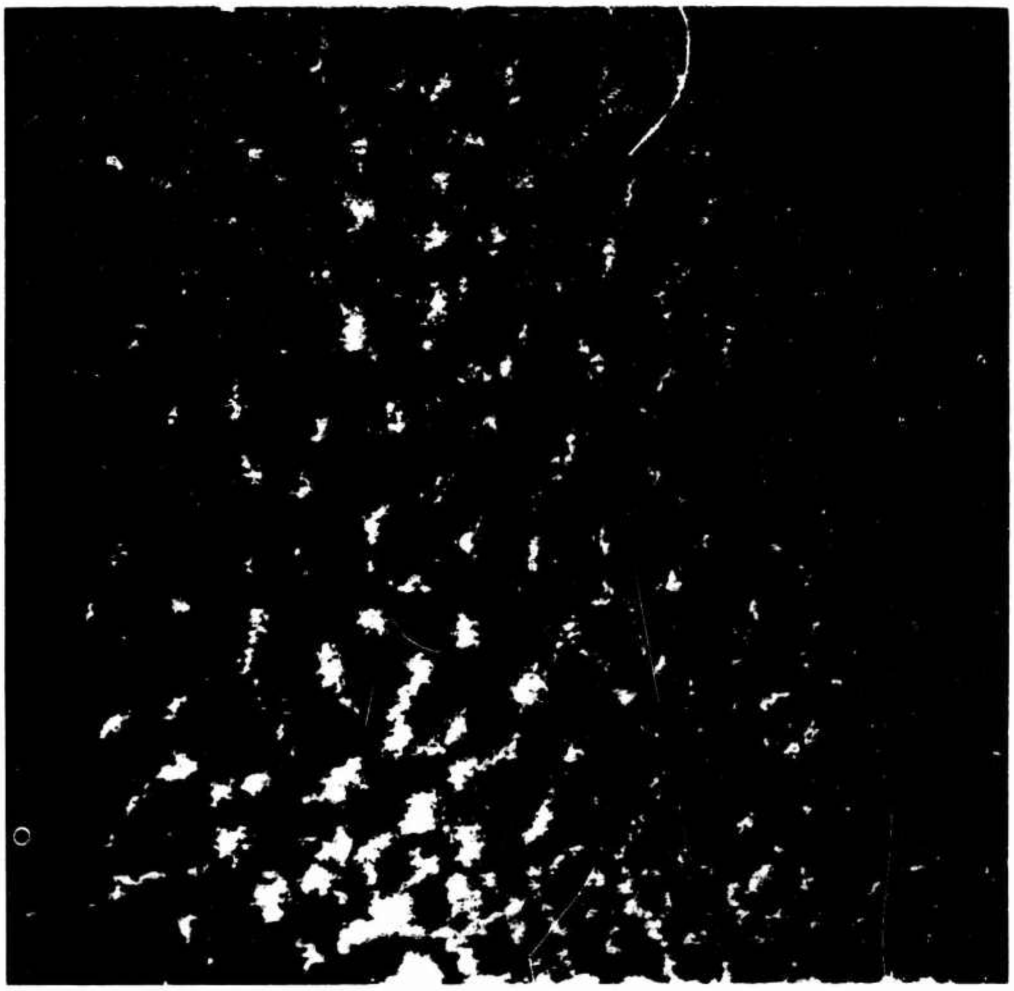
PICTURE OF THE MONTH
(January 1965)



This TIROS VII photograph (pass 6938-direct, camera 2, frame 3) shows part of a large area of stratocumulus over the eastern North Pacific Ocean, including a remarkable break or rift in the otherwise nearly uniform cloud mass. The photograph was taken on September 30, 1964, at 1747 GMT and was received at Point Mugu, Calif., via direct readout. North is indicated by the arrow.

No obvious explanation exists for the curious rift in the clouds, but mesoscale gradients of sea-surface temperature may be partially responsible. The rift is located near latitude 27° N., and it extends east-west from about 125° W. to 132° W.—a distance of over 300 n. mi. The entire area pictured is several hundred miles southwest of California and thus is far from any land. Surface synoptic maps showed the region to be in the southeastern sector of a large eastern Pacific anticyclone, with the few ships in the vicinity reporting north to northeast winds of 10 to 20 kt. and skies overcast or nearly overcast by stratocumulus clouds.

At the time of this photograph TIROS VII was in its 470th day of operation, far surpassing the record of any of the previous TIROS satellites. The picture quality continued to be good, showing little if any noticeable degradation.



Many satellite photographs have revealed extensive areas of cellular stratocumulus, but few have shown such a strikingly regular pattern as that seen here. This Nimbus I AVCS photograph was taken over the subtropical eastern North Pacific at 1930 GMT, September 6, 1964, and was received at Gilmore Creek, Alaska, via tape mode. North is indicated by the arrow.

The overall appearance strongly resembles certain patterns of laboratory-produced Bénard convection cells. However, the horizontal diameters of individual elements in this picture average approximately 20 statute miles, with a general increase in size from right to left. It is believed that the more highly reflective portions of individual elements correspond to thicker clouds and upward motion and that the darker portions represent thinner clouds and downward motion. It is also believed that the highly regular pattern with no visible streakiness is evidence of very small vertical wind shear through the cloud layer, but the lack of corroborative data makes this uncertain. There is, however, a slight tendency for the cells near the center of the picture to be aligned in north-south rows. The surface analysis for 1800 GMT, September 6, showed the area to be near the southeastern periphery of a large anticyclone and experiencing light north-to-northeast winds.

The photograph was taken looking almost vertically downward from an altitude of 464 statute miles. The picture center is at approximately 20° N., 122° W., roughly 650 statute miles south-southeast of Los Angeles, Calif. Each side of the photograph represents about 300 miles in length.

5. FOG AND/OR STRATUS FEATURES

PICTURE OF THE MONTH
(October 1965)

TIROS IX, Pass 835/834, Camera 2, Frame 4, 1028 GMT, April 1, 1965.

Snow-covered terrain, foggy ocean, and mountain-wave clouds are distinctly separated and clearly visible in this TIROS IX photograph, which is centered over southern Norway. The satellite altitude at picture time was approximately 795 km., not far from perigee. North is indicated by the arrow. The photograph was taken on April 1, 1965—the 5th anniversary of the launch of TIROS I.

The surface synoptic analysis for 1200 GMT, April 1, showed a moderately large anticyclone (1034 mb.) centered over the North Sea, accompanied by generally light winds. Fog and low stratus cover nearly all of the North Sea but very little of the adjacent land areas. The stratus extends northward into the Norwegian Sea and westward and southwestward to the British Isles. At the left of the picture, toward the horizon, a portion of the east coast of Britain is delineated rather well by the fog.

The snow-covered mountains and dark fjords of southern Norway are plainly visible, under clear or nearly clear skies. It is believed that low-level air drainage from the elevated interior kept the sea fog and stratus away from the immediate vicinity of the Norwegian coast.

At 500 mb., the anticyclone was displaced southwestward to the English Channel, with a strong northwesterly flow across the major mountain ranges of Scandinavia. Lee-wave clouds, located over central Sweden, are visible toward the right of the photograph. These clouds probably are at middle-tropospheric levels; the wavelength averages approximately 14 km.

The whitish area at bottom center of the photograph is specular reflection from the surface of the southern Baltic Sea. Little or no cloudiness exists over that region.

PICTURE OF THE MONTH
(March 1967)

Radiation fog in valleys is easily identified in satellite photographs by its unique appearance. The upper surface appears uniformly white and smooth in texture. The periphery of the overcast usually is quite well defined. Fog lying in mountain valleys often has an irregular appearance which can be compared to a contour line on a topographic chart. This occurs because the top of the fog layer is usually uniform in height and fills the valley in much the same way that water fills a depression.

The ESSA 3 photomosaic in figure 1 shows many of the valleys of the western United States filled with fog. Shaded areas on the topographic map in figure 2 correspond to the three major regions indicated by R on the satellite photograph. At the time these data were acquired a large surface High dominated the southwestern United States. This system had been stationary over the region for about ten days. The most prominent fog area lies between the Coastal Range and the Sierra Nevada, stretching from the northern tip of the Sacramento Valley to the southern end of the San Joaquin Valley. An arm of fog also extends westward along the lower Sacramento River and covers most of the San Francisco Bay area.

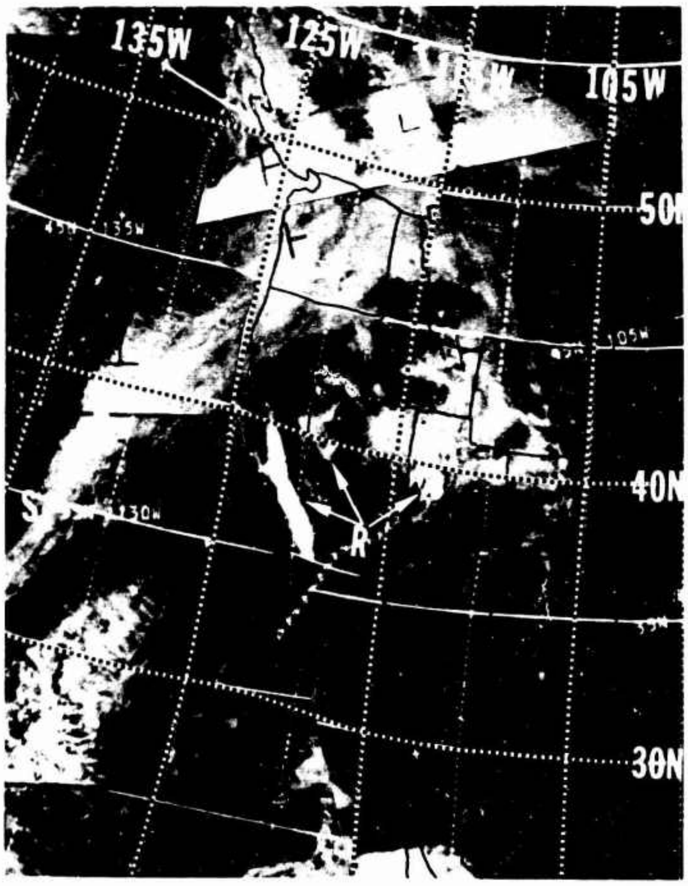


FIGURE 1.—ESSA 3 photomosaic. Passes 984–985, 1940–2134 GMT, December 19, 1966.

FIGURE 2.—Topographic map of section of western United States with major fog areas shown on figure 1 denoted by stippling. Map © 1959, Jeppesen Co. Denver, Colo.

Valley fog in northwestern Nevada covers most of the Desert Valley, Black Rock and Smoke Creek Deserts, and the area around Carson Sink. Higher ground ringing this fog area includes the Santa Rosa and Humboldt Ranges and the Stillwater Mountains on the east, and the Pine Forest Range and Virginia Mountains on the west. Fog in western Utah covers most of the Great Salt Lake Desert and Sevier Desert. Several of the higher mountain peaks and ranges protrude through the fog layer, appearing as dark spots or holes in the overcast.

Another feature of interest in figure 1 is the cold frontal cloud band along points S, P, Q. The northern edge of the high-level cloud shield is quite sharp and casts a shadow on the lower underlying cloud field from Vancouver Island to point T.

PICTURE OF THE MONTH
(December 1964)

This TIROS V photograph shows a remarkable large-scale band of up-slope stratus and frontal cloudiness just east of the Rocky Mountains. The photograph was taken on December 11, 1962, at 1832 GMT (pass 2512, camera 1, frame 8) and was received at Point Mugu, Calif. via direct readout. The center-cross fiducial mark is located approximately 80 mi. northeast of Albuquerque, N. Mex. near the crest of the Rockies. North is toward the top of the picture.

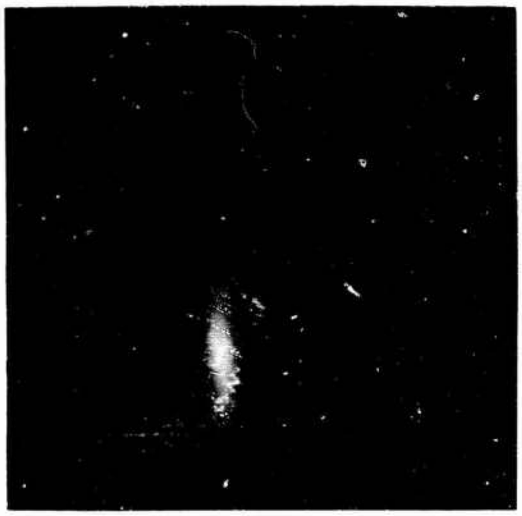
At the time of this photograph a recent surge of Arctic air had invaded the Great Plains. Midday surface temperatures over Kansas were in the teens, whereas over the western portions of Wyoming, Colorado, and New Mexico they were in the 30's and low 40's. The quasi-stationary front separating the two air masses lay north-south along the eastern slope of the Rockies, nearly coincident with the well-defined western edge of the cloud band. At the western edge, the cloudiness was low stratiform, lifting and thinning out eastward, and becoming broken middle and upper layers over Kansas and Oklahoma (northeastern quadrant of photograph).

The snow-covered higher elevations of the Colorado Rockies appear north and northwest of the center-cross fiducial mark. However, skies in that area were not completely clear; ground observers were reporting variable amounts of thin cirrus, largely invisible in this photograph. Thicker cirrus does appear toward the southwest corner.

The slightly inferior quality of the lower half of the picture is due to electronic "noise".

6. ICE AND/OR SNOW FEATURES

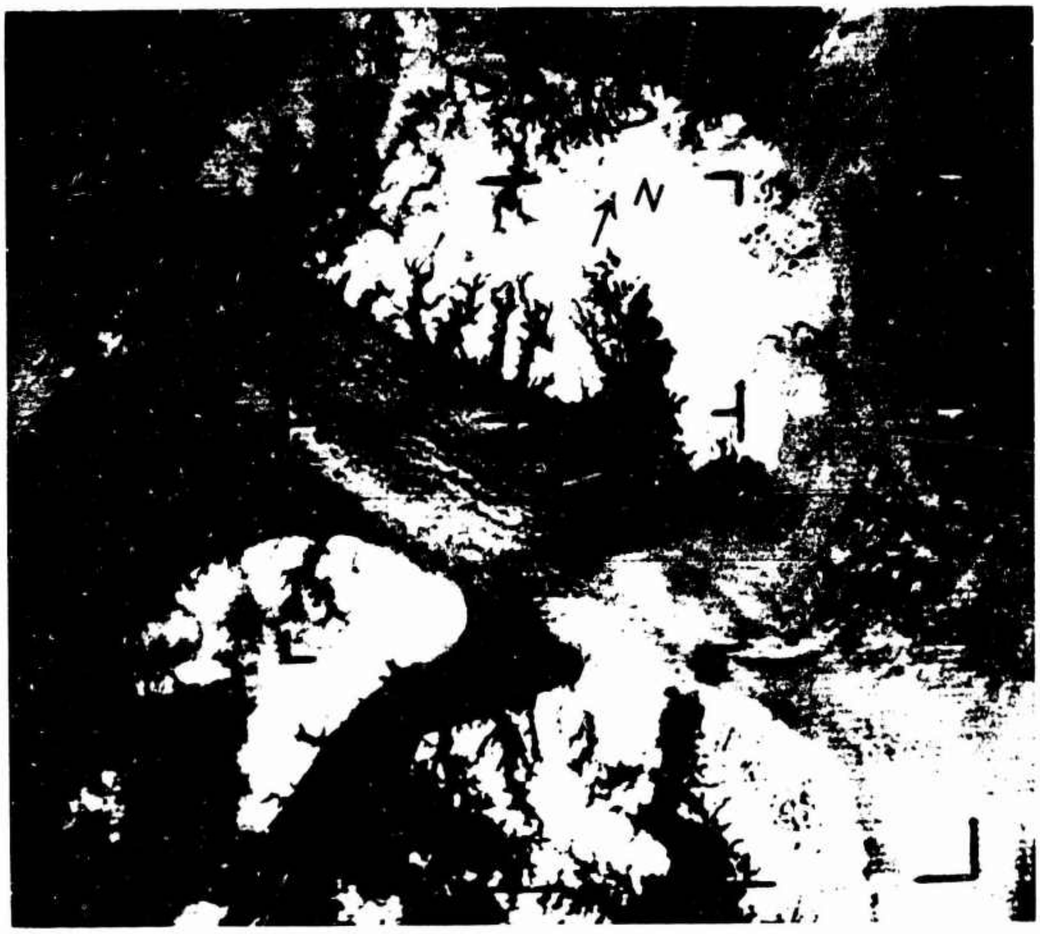
PICTURE OF THE MONTH
(February 1963)



The pictures shown here illustrate how satellite photographs, even of poor resolution, might be used for snow survey in remote, data sparse, regions. The white areas in the foreground are a mixture of snow and clouds, but the dendritic pattern that is especially clear near the arrow is the typical form of snow on rugged terrain that can be distinguished from cloud cover. The dark areas near the picture centers are caused by the rugged terrain at the western end of the Tyan Shan (Tien Shan) Range, north of the Himalayan Mountains, which might be expected to be snow covered, but at a glance the large snow-free areas can be seen contrasted with the snow. Examination of similar pictures on succeeding days would enable one to determine how much has changed (presumably the cloud cover) and how much has remained constant (possibly snow cover).

These pictures were taken 30 seconds apart about 0500 GMT, September 26, 1962 by TIROS VI when it was about 150 miles east of Tashkent, capital of Uzbekistan, USSR, viewing westward. In the background is the Aral Sea and nearly on the horizon the darker streak is the Caspian Sea. The desert areas between the camera and the Aral and between the Caspian and the Aral Seas show up as light-colored terrain (lack of vegetation) and are emphasized by cloudless skies.

PICTURE OF THE MONTH
(March 1965)



Arctic snow and ice over some of the land areas west of Greenland and low-level cloud over the intervening water are clearly visible in this Nimbus 1 AVCS photograph taken on September 16, 1964, at 1557 GMT from an altitude of 462 km. The center-cross fiducial mark is located over Lancaster Sound near 74.5° N., 85° W. Most of Devon Island is visible in the upper portion of the picture, and the peninsulas of northwestern Baffin Island appear in the lower portion. North is indicated by the arrow on Devon Island.

The surface synoptic analysis for 1200 GMT, September 16, showed a large anticyclone (1034 mb.) centered near the North Pole, with a general easterly flow in the lower levels over the pictured area. Temperatnres were near freezing. The low-level cloudiness appears to be streaming westward from Baffin Bay across Lancaster Sound, roughly parallel to the geostrophic flow. A relatively small amount of ice is believed to have existed in this water at the time of the picture.

PICTURE OF THE MONTH
(July 1964)

This TIROS V photograph of the area around the Gulf of Alaska (pass 3403/3403, camera 1, frame 7) was taken on February 11, 1963, at 2159 GMT and was received at Wallops Island, Va., via tape mode. Local Alaskan time was approximately noon. The Kenai Peninsula lies just to the left of the center-cross fiducial mark, and Kodiak Island is near the lower left fiducial mark.

The snow-covered higher elevations of the Kenai Peninsula and southern Alaska are clearly visible in this photograph. However, the skies were not completely clear at the time; many surface land stations in the area were reporting variable amounts of altocumulus and cirrus clouds. The heavily-forested lower elevations surrounding Cook Inlet, which is just west of the Kenai Peninsula, also are visible and appear as an intermediate shade of gray. Cook Inlet itself is very dark.

At the time of this photograph there was a general offshore flow in the lower troposphere, and the water areas near the coast appear dark and relatively cloud-free. The cloudiness increases southward over the Gulf of Alaska and is believed to be mainly in the low levels over that region. Toward the southeastern corner of the picture the cloudiness appears quite thick and perhaps is multi-layered.

PICTURE OF THE MONTH
(September 1963)

This unusually clear TIROS VI photograph of the area around the Gulf of St. Lawrence (pass 3257 frame 6) was taken on April 29, 1963, at 1223 GMT, and was received at Wallops Station via direct readout. North is roughly toward the top of the picture.

Although it is rather late in the season much of the very white areas in this picture are snow and ice. In particular, the Strait of Belle Isle, between Newfoundland and Labrador, has considerable ice, as do the northern and eastern shores of Prince Edward Island. Both snow and clouds probably contribute to the whitish appearance of Newfoundland. The two white spots near the centers of Anticosti Island and the Gaspé Peninsula, respectively, are believed to be snow-covered fire burns.

The small Magdalen Islands, just northeast of Prince Edward Island, also show up in this picture. This is believed to be the first time that these islands have been noticeably visible in a TIROS photograph, their visibility in this case being enhanced by shore ice.

PICTURE OF THE MONTH
(May 1967)

FRANCES C. PARMENTER

National Environmental Satellite Center, ESSA, Washington. D.C.

Arctic pack ice, ice floes, and sea ice fragments often can be seen clearly in satellite pictures. Satellite photographs often show ice formations with accompanying or adjacent cloudiness. The TIROS VIII photograph shown here is such a case.

This photograph shows an ice pack off Baffin Island. Its edge in the Davis Strait is marked by C. The dark areas to the east of points D and E are shore leads formed along the coast of Baffin Island by off-shore winds and tidal fluctuations.

The clouds photographed in this pass, in the area surrounding F, lie over the Davis Strait. These cumuliform clouds formed as cold air moved from the snow covered land and the pack ice to the warm waters of the Strait. The northwesterly flow is reflected in the handedness of the cloud field. Of interest is the increase in size and development of the cumulus bands in the area south of 60° N. and between 50° and 60° W. In this area, to the east of the Labrador Current, the ocean is warmed by the Irminger Current, a branch of the Gulf Stream.

Greenland appears at the right side of the picture. The easterly flow off the continent has produced a cloud-free area, west of G, and a brighter and broader, north-south cloud band, H–H′, where it meets the northwesterly flow.

FIGURE 1.—TIROS VIII, pass 976/975, Cl. Fr 15, 1601 GMT, February 26, 1964.

PICTURE OF THE MONTH

(June 1965)

Iceland is clearly visible in this TIROS IX photograph (pass 715/714, camera 2, frame 2) taken on March 22, 1965, at 1205 GMT and received at Gilmore Creek, Alaska, via tape mode. The satellite altitude at picture time was approximately 728 km., very near the perigee of the highly elliptical orbit. North is indicated by the arrow.

The surface synoptic analysis for 1200 GMT showed a large ridge of high pressure and generally fair and cold weather over the Greenland-Iceland area, with a northerly flow of Arctic air over the region east of Iceland. Surface temperatures at four Icelandic stations ranged from 9° to 25° F.

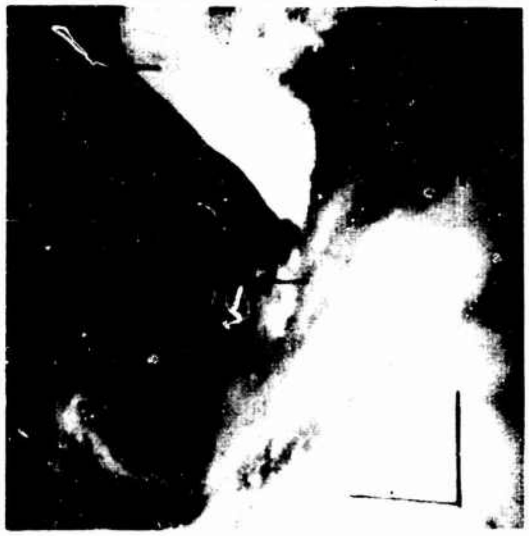
The large whitish area (A) north and northwest of Iceland represents mainly an extensive and heavy concentration of sea ice. Some cloudiness (but not overcast) is believed to exist over that region. In the darker area (B) within 50–100 miles of the coast, much smaller concentrations of sea ice were reported (generally less than $^{3}/_{10}$ coverage). Iceland itself (C) appears almost completely snow-covered and is also very nearly cloud-free. To the east and northeast, an extensive region of convective cloudiness (D) appears within the northerly flow of cold Arctic air. Many parallel lines of cumuliform elements are discernible. A solid band of frontal cloudiness (E) marks the southern limit of the Arctic air.

PICTURE OF THE MONTH
(August 1964)

(a) Pass 3114/3114, Camera 1, frame 1, 0134 GMT, January 16, 1964.

(b) Pass 4378/4372, Camera 1, frame 20, 0402 GMT, April 10, 1964.

(c) Pass 4509/4503, Camera 2, frame 30, 0042 GMT, April 19, 1964.



(d) Pass 4524/4518, Camera 2, frame 28, 0104 GMT, April 20, 1964.

These four TIROS VII photographs show the snow-covered Kamchatka Peninsula on different days under relatively clear conditions. The comparatively dark area near the center of the peninsula is a low-lying valley. Mountain ranges lie on either side of the dark area, roughly parallel to the coasts; that these appear as relatively brighter topographic features is presumably due to the greater snow depth and lesser vegetation at the higher elevations.

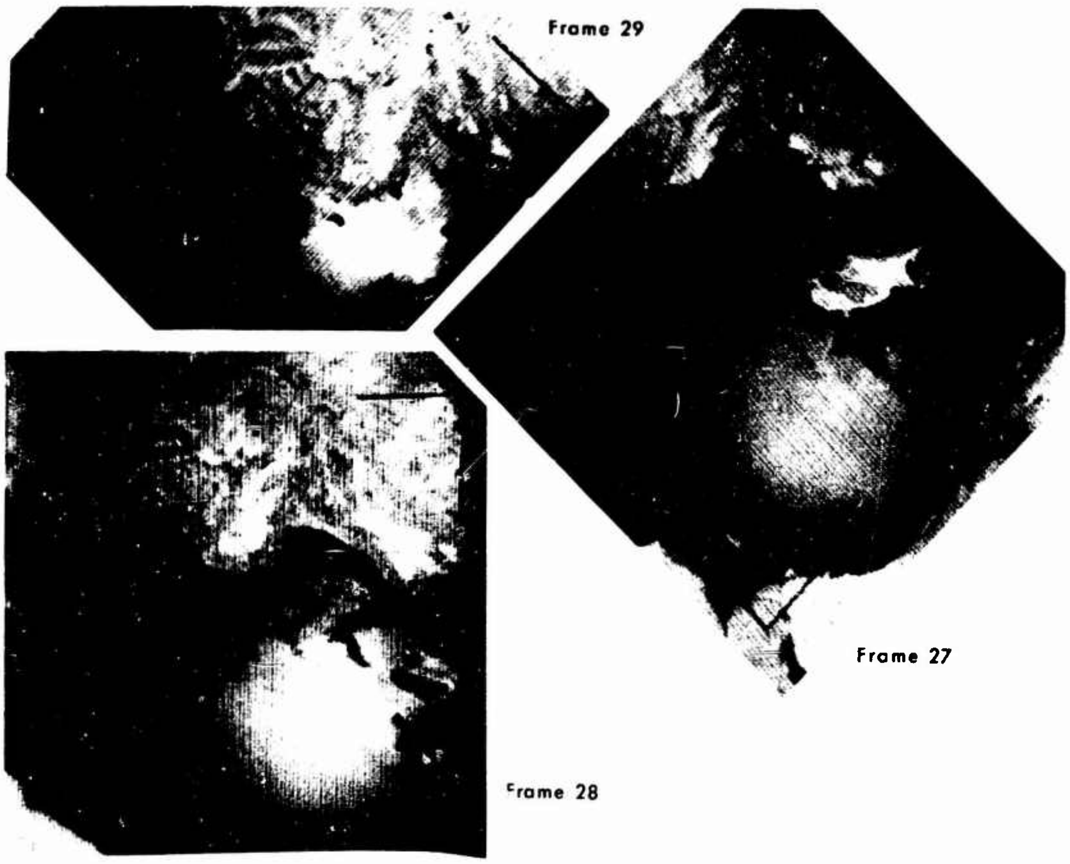
Differences in the over-water cloudiness are apparent. The clear zones paralleling the west coast in (a) and (d) occurred with light northeasterly flow in the lower levels. Downslope motion away from the elevated interior would accompany such flow. Convective cloudiness appears farther offshore. Still farther offshore, in each picture, there appears to be at least one small eddy.

In (b) there is a narrow band of cloud lying parallel to the west coast and just offshore, while farther offshore the skies are clear. This unexplained feature coexisted with weak winds and a surface ridge of high pressure oriented north-south over the same area. The clouds considerably west of the peninsula appear to be bands and streamers of cirrus, oriented north-northwest–south-southeast.

The heavy cloudiness south of Kamchatka in (d) was associated with a deepening cyclone, the center of which lay just outside the pictured area. The northern fringes of this middle or higher cloudiness are relatively thinner and are partially transparent. The snow-covered islands lying immediately south of the peninsula are not obscured by these clouds.

7. SUN GLINT

PICTURE OF THE MONTH
(October 1964)



Reflection patterns near Cyprus. Arrows indicate the same smooth sea area on two pictures, bright on 29 and dark on 28.

TIROS VIII pictures of the eastern Mediterranean Sea, taken at 1010 GMT June 23, 1963 on pass 059, were read out at Point Mugu, Calif. on pass 060. The dark vegetated highlands of Cyprus contrast with the surrounding arid lowlands. Similarly the vegetated Nile Delta is dark compared to the adjoining desert.

Cloud observations at 0600 and 1200 GMT show clear to scattered cumuli over Turkey and Cyprus. No ship reports were available to indicate the cloudiness over the open sea but the pictures give no hint of clouds except the few over land. The pressure field should have produced light northerly winds, but the directions reported at land stations were variable, indicating local influences.

An extensive diffuse sun glint reflection from the roughened sea surface contrasts sharply with irregular dark water areas. The dark areas south of Turkey on frame 28 and south of Cyprus on frame 27 indicate irregular regions where the sea surface was relatively smooth, while the brighter area farther to the south of Cyprus on frame 27 indicates that the sea surface was more roughened. This explanation, invoking reflection from a sea of varying roughness, is confirmed by comparison of the area indicated by arrows on frames 28 and 29. The very bright areas on frame 29 south of Turkey appear as a dark region on frame 28. The brightness is due to specular reflection from a smooth region at the instant of proper angular relations between satellite and sun. As the satellite moved toward the southeast (frames 28 and 27, in that order) the smooth surface did not contribute to the diffuse sun glint as did the roughened sea surface.

The pictures therefore indicate that the sea surface had irregular areas with sharp boundaries in which the surface was rather smooth. Two possible reasons may be advanced. First, the wind field may have had irregular mesoscale distribution with fairly sharp boundaries which produced corresponding sea-surface irregularities. Alternatively, the water surface may have contained organic or inorganic substances which changed the surface properties of the water so that even with a uniform light wind, some sea-surface areas remained smoother than others.

PICTURE OF THE MONTH
(December 1965)

(a) Pass 1037/1036, Camera 2, frame 10, 1657 GMT.

(b) Pass 1037/1036, Camera 2, frame 9, 1658 GMT.

These TIROS IV photographs of the eastern Great Lakes Region show some remarkable variations in solar reflectivity over Lake Erie.* The photographs were taken only 30 sec. apart, shortly before local noon on April 21, 1962. Certain portions of the lake shore which are almost invisible are delineated by dotted lines. North is indicated by the arrows.

The surface synoptic analysis for 1800 GMT, April 21, showed a polar anticyclone (1029 mb.) centered over the Carolinas, with a southwesterly return flow over the pictured region, averaging 10 to 20 kt. Thick, mostly middle-level cloudiness, associated with an approaching warm front, had advanced as far eastward as Michigan and Indiana (left portion of (a)), but generally clear skies or thin scattered-to-broken cirrus clouds existed over the immediate vicinity of Lakes Erie and Ontario. Surface air temperatures at nearby stations had risen rapidly into the 50's and low 60's (°F.) from early morning minimums of near freezing.

In (a) much of the brightness of Lake Erie is due to specular reflection which is centered near the southern shore of that lake. A small lake in northern Ohio also appears very bright. Lesser, diffuse reflectivity is visible over Lake St. Clair to the north and even over the southernmost portion of Lake Huron.

In (b), taken 20 sec. later, the proper angular relationship between satellite and sun no longer existed, and the intense specular reflection from Lake Erie is not present. However, some peculiar brightness differences which also exist in (a) are still noticeable in (b). Any or all of the conditions set forth in the following three hypotheses may have contributed to these brightness variations. (1) is believed probable; (2) and (3) are thought to be less likely possibilities:

(1) In (b) the lighter gray areas of Lake Erie may represent patches of semi-transparent cirrus clouds. These are not as noticeable in (a) because of the co-existing specular reflection;

(2) Over the eastern half of Lake Erie, the lighter gray areas may represent diffuse reflection from wind-roughened water, with the dark, rather sharp-edged areas near the southeastern shore corresponding to areas of essentially no reflection from smooth water. The latter might co-exist with great thermal stability in the lowest atmospheric layer. Aided by underlying cold water, these areas of stability (if they existed) had persisted from early morning and had not yet been wiped out by insolation and vertical mixing. Such stability would inhibit surface wind stress and thus would favor a smooth water surface having no diffuse reflection;

(3) Organic or inorganic pollutants (e.g., oil slicks) may have altered the reflective properties of certain portions of the lake.

Two small bright spots near the southern end of Georgian Bay (east of Lake Huron) and at the extreme eastern end of Lake Erie, respectively, are visible in both photographs. These represent remaining patches of ice.

*Also, see "Picture of the Month," October 1964.

PICTURE OF THE MONTH
(June 1966)

(a) Frame 22, 1321 1/2 GMT

(b) Frame 20, 1322 1/2 GMT

(c) Frame 18, 1323 1/2 GMT

(d) Frame 16, 1324 1/2 GMT

The sometimes highly variable appearance of specular reflection is well illustrated in these TIROS VI photographs (Pass 806/805) Camera 1, November 12, 1962. The photographs were taken at one-minute intervals as the satellite passed northeastward over the tropical North Atlantic Ocean (approximately 5°-25° N.). A few cloud features or areas that appear in successive photos are identified by the letters; w, x, y, z.

The large area of diffused brightness near the center of picture (a) gives way to a smaller, much brighter reflective spot in (b), which in turn becomes an irregular area in (c), and finally a very large area of diffused reflectivity in the lower left quadrant of (d).

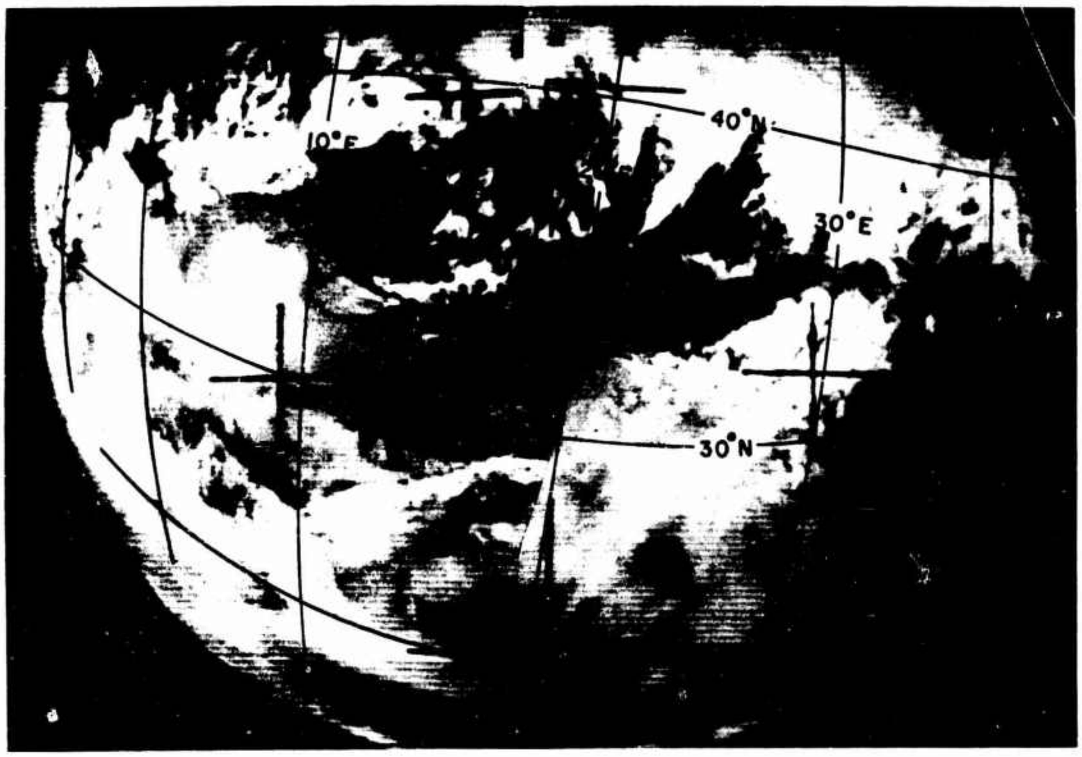
It is believed that the concentrated reflectivity in (b) resulted from a locally smooth sea surface and little or no wind; however, ship reports were too sparse to verify this belief. Without the aid of adjoining photos the reflective spot in (b) could be mistaken for a bright cloud mass.

In picture (c) the dark area immediately to the left of the specular reflection may have resulted either from a locally smooth sea (giving very little diffuse reflection) or from a possible change in the reflective properties of the sea surface. Such a change might, for example, be caused by organic material in the sea.

8. GEOGRAPHIC AREAS

PICTURE OF THE MONTH

(May 1965)



This large-scale view of North Africa and the Mediterranean area was photographed by TIROS IX (pass 232/231, cameras 1 and 2, frames 5) on February 10, 1965, at 1218 GMT. The pictures were received at Gilmore Creek, Alaska, via tape mode. The unusually broad view was obtained because the satellite was at a high altitude in its elliptical orbit (1,130 statute miles), and because the combined angular view of the two cameras, canted in opposite directions, is greater than that obtainable from previous TIROS satellites.

The extensive east-west zone of clouds over the Mediterranean is associated with a complex cyclonic system. The apparent vortex centered near 39° N., 12° E. corresponds closely to the position of a cold-core cyclone at 500 mb. The vortex cloudiness is believed to be mostly at low and middle levels and is accentuated by orographic uplift across the mountains of northern Algeria.

The streak of cloud lying ENE–WSW across Libya is believed to be cirrus, perhaps associated with a jet stream.

The eastern and western horizons are separated by more than 70° of longitude. Along 27° N., the Persian Gulf is visible near the eastern horizon, and a portion of the West African coast appears near the western horizon. Other landmarks include the Red Sea, the Nile River, and much of the southern Mediterranean coastline. Many topographic features are visible in North Africa. The dark spot near 27° N., 17° E. is an elevated region of basalt—the so-called "black mountains", or Haruj el Aswad. The larger dark area near 21° N., 18° E. is also an elevated region with some peaks above 10,000 ft.

PICTURE OF THE MONTH

(February 1966)

(a) TIROS VIII, Pass 1195-direct. Camera 1, frame 2, 2120 GMT, March 12, 1964.

(b) TIROS VII, Pass 4236/4236. Camera 2, frame 2, 2303 GMT, March 31, 1964.

(c) TIROS VII, Pass 7680/7680. Camera 2, frame 1, 2200 GMT, November 19, 1964.

(d) TIROS IX, Pass 310/309. Camera 2, frame 1, 2324 GMT, February 16, 1965.

These photographs show southwestern Alaska and the eastern Aleutians on four widely separated days under relatively clear conditions. However, no large area of completely cloud-free skies exists within any of the photographs, except for the region around Kodiak Island and southwestern Alaska in (a) and the region around Nunivak Island and western Alaska in (d) (near top).

The snow-covered land mass of southwestern Alaska is remarkably well defined in all four pictures. In (a) and (d) a large area of Bering Sea ice also is visible. Surface air temperatures were particularly low at the time of photograph (d), near 0° F. at St. Paul's Island (57° N, 170° W., near the edge of the ice pack) and far below zero in interior Alaska.

Low clouds banked heavily against the northern slopes of the eastern Aleutians and the Alaska Peninsula in (b) and (c), and to a lesser extent in (d), under the influence of moderate N or NW flows. Lee clearing is pronounced. The remarkable chain of downstream eddies visible in (b) appears to emanate from the vicinity of mountainous Unimak Island.

Cloud-free TIROS photographs of southwestern Alaska and the Aleutians are relatively uncommon because of excessive cloudiness in summer and darkness in winter. Photograph (c) was taken in late November when even at midday the solar elevation is quite low.

PICTURE OF THE MONTH
(March 1966)

(a) TIROS IV, Pass 751-direct, Camera 2, frame 6, April 1, 1962. 2020 GMT.

(b) TIROS IV, Pass 1020-direct, Camera 2, frame 15, April 20, 1962, 1403 GMT.

(c) TIROS VIII, Pass 1094/1093 Camera 1, frame 26, March 5, 1964, 1933 GMT.

(d) TIROS VII, Pass 4602/4601, Camera 1, frame 23, April 25, 1964, 1551 GMT.

These photographs of the western Great Lakes Region were taken on different days during late winter and spring. (b) and (d) show the region under almost completely clear skies; (a) (c) contain considerable cloudiness but with much of the lakes still visible. Differences in shore ice, snow cover, and land- and water-based convective clouds are apparent.

In (b) considerable ice is visible along the south shore of Lake Superior, with lesser amounts in bays along the north shore and in Green Bay (northwest of Lake Michi-

gan). Lake Nipigon and numerous smaller Canadian Lakes are covered with ice and snow. Forested snow-covered regions in Canada appear as an intermediate shade of gray. Photograph (a) reveals a similar and more extensive lake-ice distribution, less readily apparent because of co-existing land-based convective cloudiness. Multi-layered clouds exist toward the southeast corner of (a).

The greater amount of ice in (a) and (b), as compared with (c) and (d), probably reflected the colder 1962 winter in that area.

Water-based convective clouds are visible in (c), beginning near the center of Lake Superior and extending in narrow parallel rows to the south shore. At that time a deep cyclone (976 mb.) was centered over southwestern Quebec, just east of the pictured area, and Lake Superior lay beneath a northerly flow of very cold air (midday temperatures far below freezing). Wisconsin was largely cloud-free but with a heavy snow cover bordering the western shore of Lake Michigan. Dense clouds obscure Lower Michigan and the eastern shore of Lake Michigan.

9. MISCELLANEOUS

PICTURE OF THE MONTH
(June 1963)

This TIROS V photograph of the Great Lakes area was taken at 2037 GMT, June 20, 1962, and was received at Wallops Station, Va., on Pass No. 019 via direct readout (camera 1, frame 4). Local mean solar time at Chicago was approximately 2:45 p.m. Partial outlines of the lake shores and the state boundaries have been added to facilitate location. CHI=Chicago and SSM=Sault Ste. Marie.

The unusually complicated cloud pattern is not wholly explained, but is doubtless the result of several influences. Winds over lower Michigan and Indiana at the surface and 850-mb. levels were generally N or NNW at this time, and a pronounced crescent-shaped clear area appears immediately to the lee of the relatively cold water of Lake Michigan. This clear crescent has its greatest width in the region near South Bend, Ind. Elsewhere over lower Michigan and Indiana afternoon cumulus clouds predominate.

Superimposed on this convective pattern are the effects of a weak cold front which lies ENE–WSW across lower Michigan and southern Lake Michigan, and thence westward across extreme northern Illinois. Cumulonimbus clouds are reported along the front east of Muskegan and west of Chicago. The whitish appearance of much of Lake Michigan is believed to be due to low stratus along the front and in the cooler air behind it, but it could also be due partly to specular reflection. In contrast, Lake Huron appears dark and almost completely cloud free.

The bright triangular patch near Green Bay, Wis., is a dense mass of stratocumulus cloud.

PICTURE OF THE MONTH

(July 1966)

(a) Pass 3039/3038, Camera 1, frame 6, 1637 GMT, January 30, 1966.

(b) Pass 3039/3038, Camera 1, frame 7, 1636 GMT, January 30, 1966.

(c) Pass 3053/3052, Camera 1, frame 9, 1605 GMT, January 31, 1966.

(d) Pass 3067-direct, Camera 1, frame 5, 1538 GMT, February 1, 1966.

These TIROS-X photographs were taken on January 30–31 and February 1, 1966, during a period of severe winter weather over the eastern United States. On January 30 ((a) and (b)) extremely cold air was streaming eastward and southward over the southeastern States and the Gulf of Mexico (coastlines are added). Intense low-level convection was occurring over the Gulf, visible as very narrow parallel cloud lines beginning near the northern shore, and becoming much larger convective elements over the southern Gulf (lower left of (b)). Land areas appear largely clear, and a heavy snow cover is visible in (a) from the mid-Mississippi Valley eastward.

On January 31 (c) cold air continued to dominate Florida and the adjacent Atlantic, with much convection again visible over the Atlantic. Morning minimum temperatures over northern Florida were far below freezing.

On February 1 (d) the middle Atlantic States appear under a deep snow cover—that area was still largely immobilized from the effects of the blizzard of two days earlier. The coastline from Chesapeake Bay to Long Island is highly visible. A band of warm frontal cloudiness obscures the Carolinas and extends westward beyond the picture into yet another snowstorm over the Ohio Valley.

PICTURE OF THE MONTH
(October-December 1963)

L. F. HUBERT

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[Manuscript received July 17, 1963]

The Monthly Weather Review series "Picture of the Month" is continued here as a contribution in memory of Dr. Harry Wexler. The picture (fig. 1) chosen for this issue is particularly appropriate. It displays the sort of unsolved problem that always stimulated Dr. Wexler—the problem of air-sea interaction and the endless complications of atmospheric hydrodynamics.

This TIROS V two-frame mosaic (pass 032/031, frames 24 and 26) shows the region around the Canary Islands, Madeira Islands, and a small portion of northwestern Africa. It was taken at about 1650 GMT, June 21, 1962, and read out at Wallops Station. Frame number 26 was published earlier by Hubert and Kruger [1] to illustrate small-scale eddies downstream from Madeira Island, which can be seen in the upper left. The principal area pictured here is the Canary Islands which extend across the middle of the picture, part of Africa, and the Atlantic Ocean about 150 n. mi. south of the Canaries. The clouds north of the

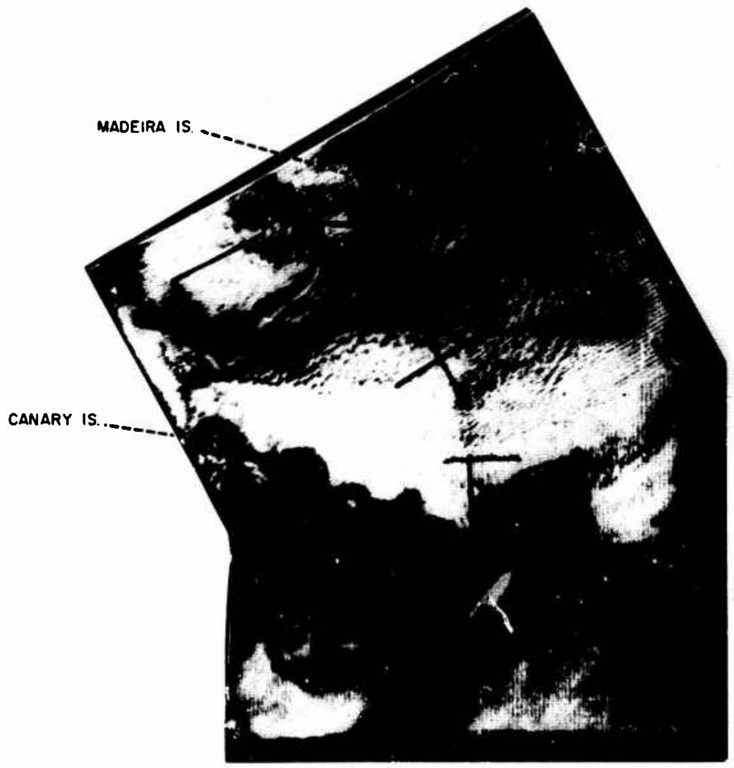


FIGURE 1.—A two-picture mosaic, frames 24 and 26 from TIROS V, pass 031/032, Camera 1, taken at 1650 GMT, June 21, 1962. North is toward the top of the picture. Stratus and stratocumulus clouds beneath a low inversion terminate along the Canary Islands chain. A smaller clear area is also produced downwind from Madeira Island.

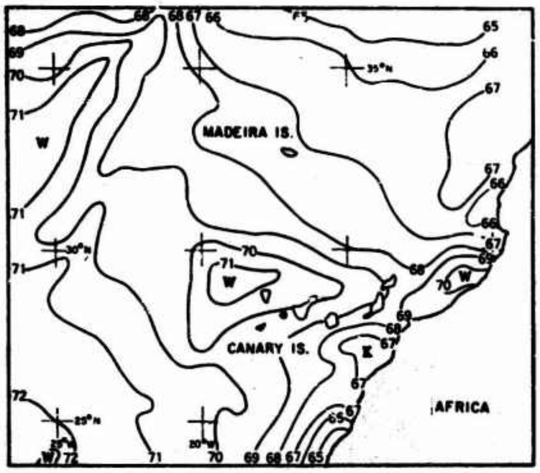


FIGURE 2.—Mean sea surface isotherms (°F.) for June in the Madeira—Canary Island region, prepared from data and analysis furnished by the Oceanographic Data Center, Washington, D.C.

Canary Islands are stratus and stratocumulus. Their marked discontinuity at the islands reflects a strong thermal and/or dynamic mechanism because north to northeast winds were blowing across the cloud edge.

Climatologically, this region is one of relatively cool water and low-lying stratocumulus clouds topped by a pronounced temperature inversion. On this particular day, the 1200 GMT sounding at Funchal, Madeira, and the 0000 GMT sounding at St. Cruztenri, Canary Islands, both revealed an inversion of 3°C. near the 950-mb. level. No detailed synoptic oceanographic data are available but mean monthly temperatures reveal some interesting aspects.

Figure 2 shows the mean sea surface temperatures for June, prepared from data and analysis provided by the staff of the National Oceanographic Data Center, Washington, D.C. The pronounced warm center just northwest of the Canaries tempts one to hypothesize cloud generation due to heating from the sea surface when northerly flow moves the air toward warmer water, and clearing when the gradient is reversed. This model has some difficulties however.

First, the lack of heating from below or even the commencement of cooling seems inadequate to account for the very abrupt cloud evaporation observed in figure 1, in view of the northerly winds which should advect the cloud deck over cool water.

Second, this effect, in various degrees of development, is frequently seen downstream from islands in this type of meteorological situation, during months when the *mean* sea surface isotherms show no reversal of gradient.

Against this objection one could argue that daily isotherms may be quite different from monthly mean isotherms. It is therefore possible that the gradient does reverse when the abrupt clearing occurs.

Clearing sometimes can be seen both downwind and upwind from islands in regions where there is frequently a low and strong inversion. Notice for example, the clear area around Madeira Island in figure 1. This suggests a strong obstacle effect of the islands upon airflow and upon the inversion height, which may be independent of ocean surface heating or cooling.

Much of the island terrain extends above the inversion so that air must be deflected mostly in the horizontal rather than vertically when the wind flows across the region. It is suggested that under proper circumstances, a standing wave in the inversion interface might be produced in such a way that its trough occurs just south of the islands. The convective condensation level of the moist air beneath the inversion at both Madeira and the Canary Islands is just at the inversion base. Therefore if the inversion sloped downward sharply downstream, clouds would be dissipated as the winds carried them to lower levels.

The clear area extends some 150 mi. south of the islands however. Some mechanism must be invoked to account for this broad cloudless area. A standing wave in the inversion with its crest *beyond* the clear region seems too long. Perhaps cooler ocean waters south of the islands are a factor tending to suppress cloud reformation.

Whatever the complete explanation, it seems very likely that the presence of the islands is critical. They represent significant obstacles to both the oceanic and atmospheric flow, thereby deforming the temperature structure of both media. The terrain itself may comprise a heat source for the atmosphere in a manner that would help maintain the sharp cloud edge.

Everyone who knew Dr. Wexler can appreciate how this problem would have whetted the appetite of his inquiring mind. I would like to point out that, in a way, he has bequeathed this fascinating puzzle to us, because we have been able to recognize it and to define its extent only with the meteorological satellite, an advancement so vigorously sponsored by him.

REFERENCE

1. L. F. Hubert and A. F. Krueger, "Satellite Pictures of Mesoscale Eddies," *Monthly Weather Review*, vol. 90, No. 11, Nov. 1962, pp. 457–463.

PICTURE OF THE MONTH
(April 1964)

The overall guiding philosophy of the "Picture of the Month" series is the presentation of outstanding or unusually puzzling satellite views of meteorological phenomena and/or pictures of unusual quality. The current selection, a TIROS VIII photograph taken by the APT (Automatic Picture Transmission) camera, represents a slight deviation from that philosophy.

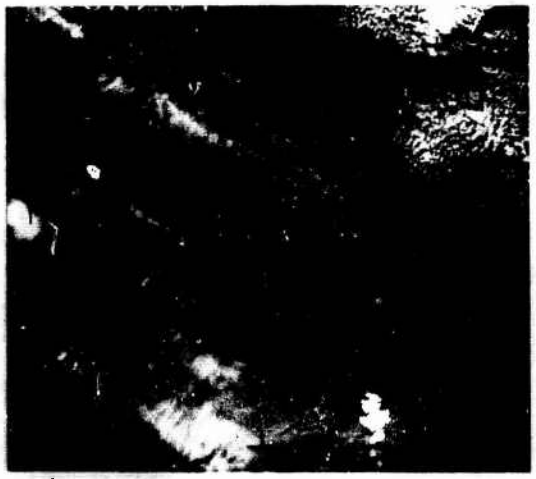
APT has been available only since the launching of TIROS VIII on December 21, 1963. Early photographs received by this method were of inferior quality, largely because of the sealtoping and "venetian blind" effects caused by interaction between the earth's magnetic field and the camera's vidicon scanning beam. At the time of this picture (1902 GMT, February 16, 1964) the satellite attitude was such that these effects were temporarily minimized; by comparison with earlier APT pictures the improved quality is readily apparent, despite the many photo and electronic transformations necessary to reproduce this printed version. It is expected that future APT systems will be corrected to eliminate magnetic effects.

This particular photograph, showing an extensive area of stratocumulus clouds southwest of California, was taken on pass 832 (frame 2) and was received at the APT ground station at Pt. Mugu, Calif., where it was first recorded on electrolytic facsimile paper. (Similar APT installations now exist at over 40 locations in the United States and elsewhere.) Much of the California coast also is visible in the photograph. The operationally-produced latitude-longitude grid was added to the picture after it was received at the ground.

The curved line of clouds bounded by the arc of reduced cloudiness, extending westward and northwestward from near 30° N., 120° W. may have been associated with the remains of a cold front that moved through southern California the previous day.

PICTURE OF THE MONTH
(November 1964)

(a) Nimbus APT, Pass 137, 1617 GMT, September 6, 1964.



(b) Nimbus AVCS, Pass 138/137, Camera 2, Frame 21, 1618 GMT, September 6, 1964.

These photographs were taken almost simultaneously by different camera systems of the Nimbus I satellite. At the time (near local noon, September 6, 1964), Nimbus I was passing northward over the eastern United States at an altitude of approximately 425 statute miles.

Photograph (a) was taken by the APT (Automatic Picture Transmission) camera and was transmitted immediately and simultaneously to several ground receiving stations which were within range. Photograph (b) was taken by the high-resolution AVCS (Advanced Vidicon Camera System) about 1 min. later than (a), and it shows the area around Lakes Erie and Ontario in greater detail. Photograph (b) was first stored on magnetic tape within the satellite, was received at the Rosman, N.C., antenna site on the following orbital pass, and was then immediately transmitted via wide-band communication link to the Goddard Space Flight Center, Greenbelt, Md.

At the time of these two photographs, a surface anticyclone (1023 mb.) was centered over Pennsylvania, with clear or nearly clear skies over much of the Middle Atlantic region. Numerous topographic features are visible in (a), especially in the mountainous areas of Pennsylvania and West Virginia, which lie just above and to the left of the center-cross fiducial mark. Also visible in (a) are portions of Lakes Erie and Ontario (near top of picture), a large area of cumuliform cloudiness east of Lake Ontario, and the entire Atlantic coastline from Cape Hatteras to Cape Cod. The broken cloudiness east and south of Cape Hatteras is associated with the remains of a weak quasi-stationary front. In (b) the cumuliform nature of the cloudiness east of Lake Ontario is more readily apparent, as are the cirrus bands to the west.

Pronounced sun glint in (a) is centered over the waters of Pamlico and Albemarle Sounds, just west of Cape Hatteras, with lesser reflectivity from nearby waters northward to Chesapeake Bay.

These pictures from the Nimbus experiment show the excellent photographic resolution obtained. Considering the fact that both are television pictures, that (a) was first recorded at the ground on facsimile paper, and that several transformations were necessary to reproduce these printed versions, the quality is remarkably good.

Dotted lines on (b) are machine-produced latitude-longitude grid lines. The photograph is reprinted through courtesy of the National Aeronautics and Space Administration.

PICTURE OF THE MONTH
MAY 1966

(a) Gemini-V, 1025 GMT, August 26, 1965.
(b) Gemini-V, 1025 GMT, August 26, 1965 (altitude roughly 200 km.).
(c) TIROS X, pass 791/790, camera 1, frame 11, 1121 GMT, August 26, 1965 (altitude 769 km.). Rectangle shows approximate area covered by (a) and (b).

An extremely bright area of specular reflection and a remarkable spiral eddy in the stratocumulus cloud layer are visible in the two finely-detailed photographs, (a) and (b), taken by astronauts L. Gordon Cooper and Charles Conrad, Jr., during the Gemini-V spaceflight. Each shows an area roughly 100 n. mi. across (and containing about one-third overlap) along the northwestern African coast, near Agadir, Morocco. The TIROS X television photograph (c), covering a much larger area, was taken only one hour later.

The very bright area adjacent to the coastline in (a) is specular reflection appearing over the water and is completely absent in the same area of (b) as a result of the orbital displacement of the space capsule between pictures. The intense localized reflectivity probably indicates the existence of a smooth sea surface and little or no wind over that particular area. The 1200 GMT surface synoptic analysis showed the usual summertime Azores anticyclone, indicating a moderate northeasterly geostrophic flow along the coastal region. Actual surface reports from scattered stations showed generally light winds.

The clockwise cloud spiral in (b) might represent a mesoscale lee eddy induced by the flow around Cape Ghir, just to the north (visible in (a)). The Atlas mountains, with numerous peaks above 10,000 ft., extend to within 100 mi. of Cape Ghir; they may also have had some influence. Gross features of the cloud spiral are discernible in the lower-resolution TIROS photograph, (c)[1].

Numerous fine-quality photographs of the earth have been taken during manned orbital spaceflights.[2] All were initially recorded on 70-mm. color film; they appear much more spectacular in that form than in black-and-white.

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[1] For another view of mesoscale eddies near Africa see "Picture of the Month," October-December 1963, p. 633.

[2] Also, see "Picture of the Month," September 1965, p. 546.

Navy Weather Research Facility (NWRF 33-0667-125)
PHOTOGRAPHS FROM METEOROLOGICAL SATELLITES (A Collection of the Picture of the Month Series from *Monthly Weather Review*, January 1963 to May 1967). June 1967. 50 Pictures with Explanatory Test.

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1. Meteorology.
2. Satellites.
3. Cloud Photographs.

I. Title: Photographs from Meteorological Satellites (A Collection of the Picture of the Month Series from *Monthly Weather Review*, January 1963 to May 1967).
II. NWRF 33-0667-125 TASK 33

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